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THE ARTIFICIAL SILK INDUSTRY.

THE artificial silk industry, of which France has a right to be proud, is reaching a period of heavy production. A wealthy company has established extensive works at Besançon, the products of which are becoming more and more widely employed in the silk industry. Silk dealers and the manufacturers of fabrics are, however, the only ones who are acquainted with artificial silk. The public is unable to perceive any difference between the artificial and the genuine product.

Artificial silk is as handsome and as brilliant as the most esteemed natural silks. It is simply not quite so strong as the latter, and so is especially employed for fabrics of which the warp is made of ordinary silk of inferior quality or else for ribbons with a cotton warp and for all kinds of fancy goods, for linen and silk gowns, theatrical costumes, etc.

Through proper precautions and by special processes dyers give this artificial product all the richest shades of color. The fundamental principle and general processes of manufacture were discovered and patented by Count de Chardonnet, chief of government engineers.

Gun cotton is first manufactured by the ordinary processes, that is, by the action of a mixture of sulphuric and nitric acid upon well dried carded cotton and then washing, drying, etc. Instead of cotton, wood pulp, such as that used for the manufacture of paper, may be employed; but there is no advantage in this at the present price of cotton.

The gun cotton is dissolved in a mixture of alcohol and ether under a strong pressure (40 to 50 atmospheres) in special apparatus. In this way there is obtained a viscid collodion thicker than that used in photography. This has to be filtered under pressure with the greatest care, for it must not retain the smallest fiber of undissolved gun cotton.

The collodion, well clarified, is led by a large pipe to the spinning room, and, always under a pressure of from 40 to 50 atmospheres, is distributed by smaller pipes to all the spinning frames.

Upon the pipes that occupy the length of each frame are fixed the spinning nozzles, each of which consists of a small reservoir that communicates with the feed pipe. The reservoir terminates in a glass tube drawn out to a point provided with an orifice having a diameter of a hundredth of a millimeter.

The thread of cotton that issues from this tube (an imitation of the spinneret of a silk worm) was, in the first place, plunged into water, which solidified it immediately in taking up the alcohol of the collodion; but much better results are now obtained by dry spinning, in which the solvent (alcohol and ether) rapidly evaporates, and the threads are so dry that they do not stick together when the machine winds them around the bobbins.

It requires three or four cocoon threads to constitute a warp thread and more to form thrown silk. The threads of the artificial silk are, like those of the ordinary article, submitted to "throwing" and "twisting," but, before working it up, the new silk has to be denitrated. In fact, the product is, upon the whole, merely gun cotton, and would, therefore, prove very inflammable and even detonating. The finished skeins are immersed in a solution of ammonium sulphide, which destroys the nitric acid combined with the cotton. The whole of the nitric acid might be removed in this way, but a small quantity is left that causes no inconvenience. The Chardonnet silk, thus denitrated, loses none of its qualities and remains but slightly combustible; no more so, in fact, than is spun cotton of the same size.

Since the industry has become able to furnish unlimited quantities of the product with a saving of fifty per cent. in the cost, as compared with that of ordinary silk, the applications of it have become very numerous.

It is in this way that is manufactured the "silk straw" that is so much in favor for women's bonnets, with threads of silk juxtaposed and held by an elastic sizing in such a way as to constitute flat ribbons a few millimeters in width. This silk straw allows milliners to obtain entirely new and striking effects.—La Nature.

FIG. 1.—MANUFACTURE OF GUN COTTON.

FIG. 2.—WASHING OF GUN COTTON.

FIG. 3.—MANUFACTURE OF COLLODION.

A NEW BASIS FOR PHOTO-MECHANICAL PROCESSES.*

A PRINT is made in the usual manner upon gelatino-bromide paper; that is to say, the paper is exposed under a negative, developed with hydroquinone, fixed and thoroughly washed. The print when finished is brushed over with a concentrated aqueous solution of persulphate of ammonium. The image bleaches in about a quarter of an hour. If we now remove from the surface the solution we have used by rinsing the print in cold water, and rub the wet film, the natural heat of the hand will dissolve those parts which were previously reduced by the developer. The white portions of the film which had not been exposed to light will remain unchanged.

A gelatine relief is thus obtained. Where the film was darkest the paper is laid quite bare. About half the gelatine remains in the half tones, while the film is thickest in the high lights.

If the gelatino-bromide of silver is not too sparingly coated, the relief, while still wet, is nearly as strong as shown in a freshly developed carbon print. After drying it may still be recognized with ease. To render it still more visible, the gelatine may be stained with an aqueous solution of methyl-violet. A perfect negative may be thus produced, as the thicker portions of the film absorb more dye than the thinner.

Reliefs produced in this way should be of use in various photo-mechanical processes, as we shall show later on.

The same process may be applied to negatives taken on bromide plates, but the relief is not always so perceptible upon the ordinary rapid plates of commerce as on the less sensitive bromide paper. I have consequently taken the

* Translated from the Photographisches Archiv by The British Journal of Photography.

latter for the illustration of my point, and I would recommend others to use bromide paper also for their first experiments.

For the production of these reliefs the negatives should not be developed with pyrogallic acid. I have already shown that a product of oxidation from the pyrogallic acid may be retained with the silver in the film, and renders it less soluble.* This tanning action would, of course, counteract the subsequent process, consequently it is necessary to develop with a stainless developer, as, for instance, hydroquinone or para-amidophenol. It is also necessary that the negatives should not be intensified with mercury, as this has a very strong tanning action.

Negatives bleached with persulphate of ammonium and then, like carbon prints, developed in warm water by rubbing away the exposed portions of the film, may be converted directly into positives by staining with a dye. If the plate has not been over-exposed and over-developed, a stained transparency is obtained that may be used in the lantern, or for window decoration.

The same results are obtainable with prints upon gelatino-chloride paper. It is immaterial whether the image is fully or only partially printed and then developed with an acid developer. The prints may be toned or untoned. The combined toning and fixing bath also has no injurious effect, although the film may be tanned by the alum present.

In all these experiments it may be seen that the metallic silver forming the half tones is only at the surface of the film. It extends to the glass or paper only in the darkest portions.† In the case of gelatine prints the paper is laid bare only in the deepest shadows. These results confirm my theory of the structure of the negative, which has only been based hitherto upon microscopic observations and experiments made by paring the films.‡ In searching for the causes of these phenomena it was found that persulphate of ammonium (or potassium) not only bleaches the metallic silver, that is to say, converts it to a colorless salt, but that the saturated solutions also have an appreciable solvent action upon the metallic silver.§

The production of the relief may be due either to further tanning of the film or to increased solubility of the parts where silver had been reduced. I have been able to determine that the latter is the case. A finished gelatine print was half brushed over with persulphate of ammonium. After rubbing it in warm water, the image was still perfect on the half that had not been brushed over. On the side that had been brushed those parts were dissolved where the silver had been reduced, while the portions where silver had not been reduced remained unaffected. Those portions of the gelatine film in which the metallic silver is embedded consequently become more soluble when treated with persulphate salts than those parts which are free from silver.

Only two alternatives are possible: First, that the gelatine is affected in the exposed portions prior to the experiment, so that the persulphate salt has a different action upon it in comparison with ordinary gelatine, or, second, that the entire change in the gelatine first happens when the persulphate salt acts upon the silver contained in the film.

The first alternative must not be rejected immediately, as many photographic chemists hold that the gelatine absorbs bromine from the exposed bromide of silver, since it acts as a sensitizer.‖

I thought I could decide this question by converting into bromide of silver, with bromide of copper, half of a gelatine print, and then removing the bromide of silver with hyposulphite of soda. After treating the whole picture with persulphate of ammonium, a reversed relief was produced on the half from which the silver had been removed, when the print was rubbed in tepid water. The previously dark parts were left and the lights were dissolved. The same happened with a bromide print. A tanning action might be ascribed to the bromide of copper for those portions of the film containing the silver. In that case, however, a mixture of the copper salt and the persulphate of ammonium must be less active than the latter alone. Actually, this was not the case. One must therefore conclude that the solubility of the gelatine, where the silver is present, is a secondary process due to the reaction of the persulphate salts upon the metallic silver.*

A further proof of the close connection between the alteration of the gelatine and the bleaching of the silver lies in the fact that when the action of the persulphate salt has been too short, the deepest shadows (still retaining their color) remain unchanged in tepid water, while the half tones dissolve.

Concerning the use of this process for photo-mechanical purposes, it must be remembered that the relief is reversed, as in the processes at present employed. Bichromated gelatine becomes insoluble where it has been exposed to light. It must therefore be exposed under a negative for process work, collotype, and the carbon process. The same is necessary in Warnerke's process, which has for basis the retention of the oxidized product of the pyrogallol at those portions of the gelatine film retaining the silver, and there tanning it. In the course of my experiments I hit upon some other methods of producing a relief from a silver print on gelatine. Hitherto they have all proceeded from the solubility of the unexposed parts, thus leaving the exposed portions intact. For instance, if a finished gelatino bromide print is treated with a concentrated solution of bichromate of ammonium, the unexposed portions will swell and become soluble in warm water, while the parts containing the silver will remain unchanged. I will not refer at greater length to this, because the process does not seem to offer any particular advantages in comparison with Warnerke's. As an analogue to the process with persulphate salts, the behavior of ferric chloride and gelatine can alone be instanced. Ferric chloride has a very strong tanning action upon gelatine. Upon exposure to light, ferrous chloride is formed, which renders the gelatine soluble.

To obtain by my method a suitable relief for photo-mechanical etching, a print must be made under a transparency, or the image may be obtained direct in the camera upon the film, which is to be subsequently used as the etching ground. I coated some copper plates with gelatino-bromide emulsion. The emulsion was not of the highly sensitive kind required for instantaneous plates, but of medium rapidity, as used upon photo-mechanical plates. For photo-mechanical purposes it is necessary that there should be great opacity of image as well as absolute freedom from fog. (It is extraordinary how well the emulsion keeps upon a copper support. Plates that have been kept some weeks are not yet spoilt.)† Such a plate was exposed behind a screen in the camera.‡ Upon development in normal hydroquinone developer, a vigorous image was produced, without the least trace of fog. The fixing also began normally; but the destructibility of the copper soon made itself apparent. The copper decomposed the silver salt liberated by the hyposulphite of soda, and was soon coated with a thin film of metallic silver not only upon the back, but also between the plate and the film, and partially within the latter also. Not only does the image thus become strongly veiled with red fog, but the film is rendered quite unfit for the production of a relief, as those portions where the silver is deposited behave precisely the same as the exposed portions.

I endeavored to remedy this fault by using the persulphate of ammonium before fixing; but it was impossible to produce a relief in that way.

A few copper plates were first covered with a thin film of silver on both sides, and then coated with emulsion. The difficulty of fixing was thus overcome. I was of opinion that the etching could not be impeded by the silver, since persulphate of ammonium is a solvent of silver. The etching would thus be initiated by the same means which had produced the gelatine relief. It also appeared possible to complete the etching with the persulphate of ammonium, as it is also a solvent of metallic copper. But these experiments failed also. The under surface of the gelatine film became soluble, through the action of the persulphate salt upon the silver support, which was in immediate contact with the former. The image no longer adhered sufficiently. Silvering the copper plate, therefore, is not a solution of the problem. The relief might be prepared upon a temporary support, and then transferred to the copper plate. But I consider the direct exposure, upon the plate used for etching, of far more value in practice, and shall now continue my experiments upon these lines.

Perhaps preparatory treatment of the plate with a thin film of resin may be of service, the same to be removed from the exposed parts by means of ether, prior to etching.

I will leave for the present the application of the process to other purposes, such as collotype, the etching of glass, the production of colored transparencies in the camera, etc., as I have not yet concluded my experiments in these directions. R. ED. LIESEGANG.

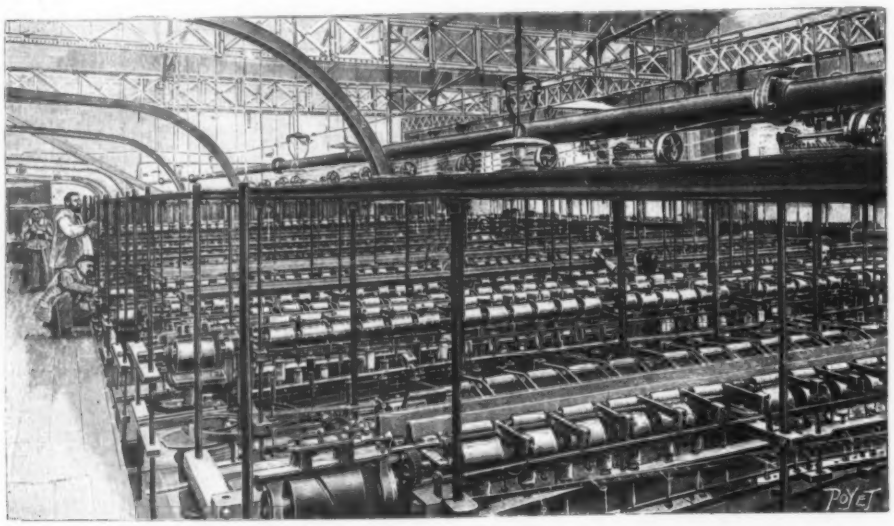


FIG. 4.—CONVERSION OF THE COLLODION INTO ARTIFICIAL SILK.

* Photographisches Archiv, 1896, pp. 168, 174.

† In the case of thin films, such as many of the celluloid films of commerce, the relief can, of course, only be slight; consequently the image formed upon them has not much depth.

‡ See Photographisches Archiv, 1897, p. 113.

§ It therefore seems not without danger to use these salts for the elimination of hypo from prints. There is also the fact that the persulphates, in decomposing the hypo, precipitate sulphur.

‖ According to the statements of Knopp, the bronzed gelatine, without further treatment, is far less soluble than the unexposed. (See Photographisches Archiv, 1894, pp. 66.)

* I express myself thus cautiously, because a prepared solution of silver in persulphate of ammonium has no solvent action upon gelatine.

† According to statements made not long ago by Russel, this was certainly not to be expected. (See Photographisches Archiv, 1887, p. 140.)

‡ The picture is thus obtained in the correct position at once for printing—right to left upon the plate.

GUTTA PERCHA—ITS PROPERTIES AND USES.

THE Journal of the Society of Arts has recently published a valuable series of articles on gutta percha by Dr. Eugene F. A. Obach. We give from this series a few interesting appliances used in the gutta percha industry for testing and working up the gum.

The physical and mechanical properties of gutta percha depend chiefly on its chemical composition, i. e., upon the relative proportion of gutta and resin or ratio $\frac{G}{R}$; but as far as the specific gravity is concerned, the constitution of the resin, and probably that of the gutta also, asserts itself. The specific gravity of gutta percha of average composition is practically the same as that of water; but the individual brands differ somewhat from each other, some being lighter and others heavier than water.

The specific gravity determinations are of considerable technical value, as is also the absorption of water by it. The softening temperature depends on the relative proportion of gutta and resin, and it is determined by the apparatus shown in our first engraving.

Fig. 1 consists of a rectangular frame, in which three strips (1, 2 and 3) of gutta percha are each held under the tension of a spring, it being so arranged that an electric contact is established and an alarm sounded as soon as one of the strips becomes soft enough to allow the spring to pull it apart. The three materials contain 2½, 38 and 60 per cent. of resin respectively, the one with the low percentage having been artificially produced. The frame with the strips is immersed in water contained in a large beaker, which is being slowly heated on a sand bath. The temperature of the water is now about 40° C. and nothing has yet occurred. On reaching 42° C. the bell sounds for the first time and shutter No. 3 of the indicator drops, which shows that the material containing 60 per cent. of resin has sufficiently softened to give way to the spring; now the bell rings a second time and shutter No. 2 drops. The temperature of the water is found to be 48° C. A rather long time elapses before the bell rings a third time and No. 1 shutter drops; and the temperature at which the strip with 2½ per cent. of resin softens is about 55° C.

A third physical property, viz., the time required by a material to become hard again on cooling, after having previously been softened in hot water, also depends chiefly on the relative percentage of gutta and resin.

The principal mechanical property is tensile strength. When gutta percha is stretched it becomes stronger, as may be determined by using the apparatus shown in Fig. 2. If a thin rod of gutta percha with thickened ends, technically called a "gut," is suspended from the bracket at the top and a weight of four pounds is attached to it, it stretches at once to a point on a scale. The weight is now gradually increased until it breaks. If the experiment had been carefully made, and the breaking strain per square inch of original area taken, as is usual, it would have worked out to be something between 2,000 and 3,000 pounds for that particular material; but if instead of the original area the final sectional area at breaking had been taken, the strain would have been found to be about 12,000 pounds per square inch.

A material having 45 per cent. of gutta and 55 per cent. of resin breaks at about 770 pounds to the square inch, while a sample in which most of the resin had been extracted with some petroleum product would require nearly twice the breaking strain. The elongation, i. e., the extent to which a gut stretches before it breaks, is also affected by the percentage of resin.

The electrical properties depend chiefly on the nature of the gutta and to a lesser extent on that of the resin; but only very slightly on the relative proportion of these two components. They also depend upon the nature and amount of the impurities, and on the water. The electrical properties, i. e., the insulation resistance and inductive capacity, are very little affected by the extraction of the resin, unlike the physical and mechanical properties.

The insulating property of gutta percha was first observed by Dr. Werner von Siemens in the year 1846. Faraday also noticed this property somewhat later, and recommended gutta percha for insulating purposes in March, 1848. The lecturer said:

"I should like to show you the two principal electrical qualities of gutta percha by an experiment. I have here an electroscope (Fig. 3), with a flat brass disk at the top, and below it two pith rods suspended on either side of a fixed strip of brass, which throw their shadow on to a screen in front of the instrument. I spread a thin piece of gutta percha tissue over the brass disk like a table cloth, and now charge the electroscope by means of the brass knob at the side. You observe the pith rods diverge and now remain stationary. I lay my fingers on the top of the disk, so that they are separated from it by the tissue, and you observe the rods slightly converge and then remain stationary. On withdrawing my hand they again take up their former position. Now, this simple experiment demonstrates two electrical properties of gutta percha at the same time. The fact that I could hold my hand, which through my body was connected to earth, on the other side of the thin tissue for a considerable time, without discharging the electroscope, shows its excellent insulating quality: and the binding of the electrical charge of the disk of the electroscope, indicated by the temporary partial collapse of the pith rods, while my hand rested on the tissue, showed the inductive capacity of the material. The insulation should be as high as possible and the inductive capacity, for most purposes, as low as possible; but whereas the latter is

mostly associated with other good qualities of the material, such is not always the case with a high insulation."

Gutta percha has manifold uses, such as for chemical apparatus, photographic pans, pump packing, in surgery, for making cements, medals, etc.; but probably its greatest use is for insulating compounds for wire.

Dr. Werner von Siemens first proposed the use of gutta percha for insulating purposes in 1846, and in the following year he designed a screw press for the seamless covering of wires with that material.

Fig. 4 illustrates the principle of the machinery used for covering wires with gutta percha. The wire, usually of copper, is wound on a reel or drum, D_1, and from it passes through the lower part of a cylinder, C, provided with a piston, p, which is actuated by means of a screw and nut. Usually there are two cylinders used alternately, so as to provide a continuous supply of gutta percha to the wire. The gutta percha contained in the space between the piston and the bottom of the cylinder is forced through a die, d, where it surrounds the wire, which then enters a long trough with

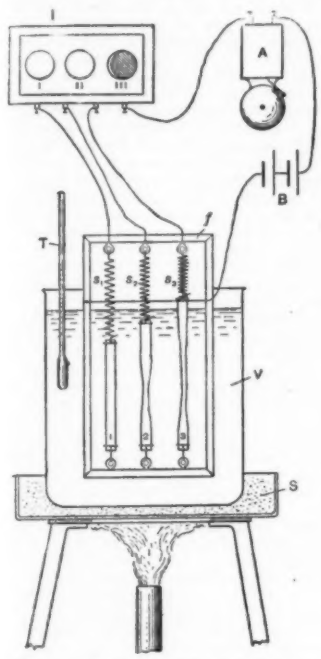


FIG. 1.—SOFTENING TEMPERATURE OF GUTTA PERCHA.

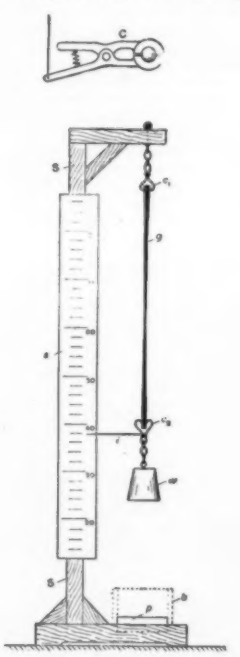


FIG. 2.—APPARATUS FOR TESTING GOLF BALLS.

wound on to a drum, D, which is then lowered into a strong cylindrical tank, T, of compressed steel, which can be closed by a screw stopper, L, in the same way as is done with breech loading guns. The large weight of the hydraulic accumulator, A, having been raised by means of the force pump, P, communication between the accumulator and the tank is established by means of the pipes, p, and the pressure allowed to act on the core for fifteen or twenty minutes, care being taken to allow all air to escape from the tank at the beginning of the operation. Any slight mechanical defect of the core, which would ordinarily elude detection, will by these means be made apparent during the subsequent electrical tests.

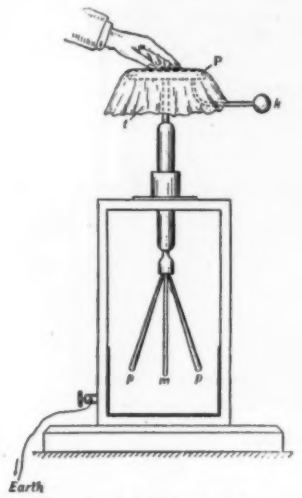


FIG. 3.—INSULATION AND ELECTROSTATIC CAPACITY OF GUTTA PERCHA.

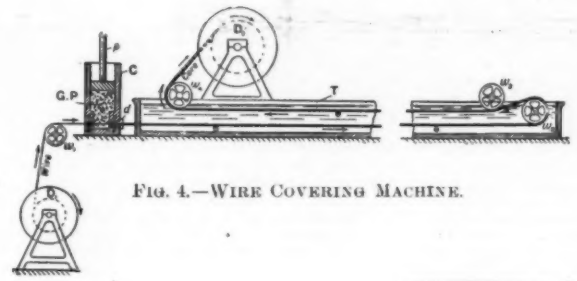


FIG. 4.—WIRE COVERING MACHINE.

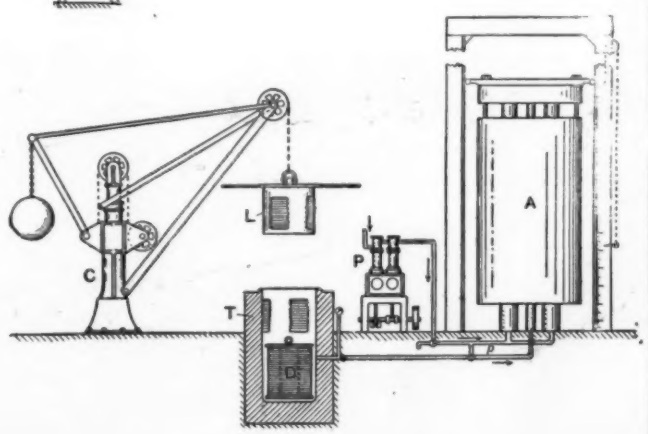


FIG. 5.—HYDRAULIC PRESSURE TANK.

THE MANUFACTURE AND TESTING OF GUTTA PERCHA.

cold water, in which it passes to and fro several times, until the gutta percha has become sufficiently hard to admit of the covered wire being wound upon a drum, D_3.

The gutta percha covered wire is kept immersed in water and tested with a high battery power for electrical insulation at a standard temperature, usually 75° F. Its inductive capacity is also tested, and sometimes it is submitted to alternating currents of very high voltage At Messrs. Siemens Brothers & Company's works, for instance, the core used for Atlantic cables is thus tested with over 5,000 volts.

Gutta percha cores which are intended to be used in deep water are, at these works, subjected to a great water pressure before being electrically tested. The greatest depth of the North Atlantic Ocean is about 3,000 fathoms, and consequently the pressure of the water at the bottom is 530 atmospheres or 3½ tons per square inch. The pressure used at Messrs. Siemens Brothers & Company's works for Atlantic cores is four tons per square inch, and the plant used for these tests is shown in Fig. 5. The gutta percha covered wire is

useful to young men who think of entering the railway service, or who are engaged in it already, we reproduce the article below:

"In the early days of railroading it was a vocation; now it is a profession. The railroad in its beginning had evoluted from the stage coach. It required for its operation and management little more than had been needed for the stage lines. As the railway systems expanded and the railway mileage increased, the railway companies found it necessary to organize departments.

"The enormous business of each company and its competition with its rivals compelled traffic departments, including both freight and passenger. The magnitude of its transactions made it necessary for each company to have an anditor and a large number of accountants and clerks. The office of the treasurer became very important, and he required the assistance of a large staff. Construction, roadbed and bridges made necessary the employment of skilled and educated engineers. The operations of the road called for general managers, superintendents and assistant superintendents, who were equal to handling, in safety and on time, the freight and passenger trains. The terminals called for special skill in their administration. The stations constantly demanded a higher grade of ability. A lawyer of distinction, supported by a large number of assistants, who should devote themselves entirely to the legal business of the company, became everywhere common.

"Thus the management of railways grew rapidly into a complex organization, requiring the highest ability, the largest experience and the best training. There are now nearly two hundred thousand miles of railroad in the United States. They are capitalized at about ten billion dollars. They earn $1,125,000,000 annually. They disburse for material and wages $793,000,000 and have a system of rates for the carriage of freight which is one-third less than that of the railroads of Europe.

"The American companies have made possible the internal commerce of the United States. This commerce is larger, by many times, than the foreign commerce of all the world upon all seas and oceans. There are directly in the service of the railways of the United States about 800,000 men, and about 2,000,000 members in the families of employes.

"The railway profession presents more attractions for a young man than any other line of business. It has greater opportunities for advancement, and its employment is more permanent. To succeed in it in any department requires health, brains, honesty and equipment. The young man must make up his mind that, if he would rise in the profession, he must never question the kind of work that is put upon him, the hours which are required of him, or the places, agreeable or disagreeable, to which he is assigned.

"Railway organization is essentially military, because upon the ability, vitality and integrity of the vast number of men in the various positions working harmoniously together depend most of the internal commerce of the country, the prosperity of business, the activities of communities, great and small, the funds of investors, and the safety of hundreds of millions of passengers.

"The young man who proposes to enter railway service should first decide whether he will take his chances for a career in outdoor or indoor work. If outdoor work, which is in the operating department, he will be immensely assisted if he has had the opportunities which are offered in the technical schools. In these days of thorough training it is almost impossible for a young man of ordinary education to get on in competition with the graduates of the Sheffield Scientific School at Yale, the scientific schools of Columbia, the special education of Cornell, the big advantages of the Troy Polytechnic and the Stevens Institute, and the instruction given in many other of the schools and colleges of the United States.

"If he selects indoor work, he must make up his mind that much more will be required of him, at first, than in commercial lines. If he is in the treasurer's department, and shows special efficiency and intelligence, when a vacancy occurs in the freight department, in any discussion that should happen between the heads of these departments, he is almost certain to be drafted for a better position by the traffic manager, and vice versa.

"Railroading differs from no other business or profession in its beginnings. The salary is small. The work is hard. It is only the few who, by cheerful readiness at all times to perform their own tasks and to stay several hours—and, if necessary, all night—to meet the requirements of the office, or to do the work of the lame, lazy and incompetent, attract the attention of their superiors, and are marked for promotion.

"When once, in any department, the young man has impressed upon the head of it his usefulness and fidelity, his career is made. With the rarest exceptions, the heads of all departments in the railway service of the United States have come up from the ranks. The presidents of all the railroads have known the day of small things, and been many years reaching their positions. The superintendents have all come from the brakes or from carrying the rod and chain in the engineering service. The superintendents of motive power have come from the footboard. The master mechanics have all come from the bench. Traffic managers and treasurers have all begun as clerks. There are but few heads of departments on our own road who have not risen from the ranks. In the operating department the general manager began as a brakeman, the general superintendent and two of the superintendents as telegraph operators, one superintendent as agent, and one as a clerk in the superintendent's office.

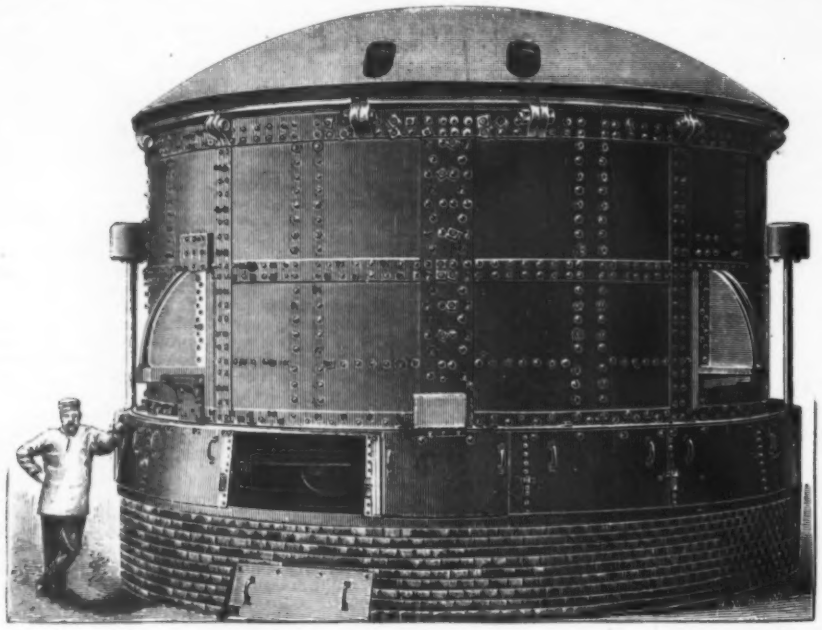
"Where the employment is so vast and the requirements so great the men at the top are constantly breaking down. The railway army is ever in the field, on the march and in the battle. Vacancies have to be filled, and filled at once. These vacancies are the inspiration and hope of those who desire and work for promotion. Sometimes a young man will do very well at first, but as soon as he reaches a place of some importance, he overestimates the hold which he has and the strength which he has attained in the confidence of his superiors. He will be often absent from the office. He will take frequent vacations. He becomes restive under rigid hours and overtime. His superior discovers that he often takes advantage of the necessary absence of his chief to be absent himself.

"In the service everyone's eye is on everyone else. There is a generous appreciation of comradeship; at the same time there is severe criticism of the conduct and character of fellow employes and officers. The moment an officer becomes careless of his duties, inattentive and out of reach when wanted, his chances for promotion are over; and the accident of a discharge or displacement are imminent. The chief mistake of the ambitious young man is in regarding the necessity for extra effort, care and attention lessened because he has been promoted to better and more important positions.

"It is in these stages of conspicuousness that many a promising railway officer loses all the advantages of his previous hard work, incurs the displeasure or distrust of his superiors, and makes it impossible, even if he reforms, to advance him. There is but one rule of success in railway service, and that is, no matter how high you get, once a hustler always a hustler, a hustler until you die or resign."

ARMORED CUPOLA FOR FORT WAELHEM.

BELGIUM for centuries enjoyed the doubtful dignity of being the cockpit of Europe, and its people are far from anxious to repeat their previous experiences in this line. It is true that the independence of the Belgian soil is under international guarantee, but in cases of emergency such safeguards are too likely to prove illusive, and the campaign of Ulm furnishes a precedent for the violation of neutral territory, if great strategic advantages are to be gained thereby. Belgium has accordingly deemed it prudent to reinforce such protection as is afforded by treaty by the establishment of a formidable series of modern forts, equipped with heavy guns fixed in an armored turret or cupola of the type originally introduced by Gen. Brialmont. One of these cupolas, constructed by the Ateliers de Construction de la Meuse, Liège, is illustrated above, and photographs of it were shown at the Brussels Exhibition. The cupola differs from a ship's turret in the fact that the body being sunk in a pit, the sides do not require armoring, while the top being domed, it is very unlikely to be struck a fair blow by an enemy's projectile. Experience has shown very conclusively the great resisting power of inclined armor. The particular cupola illustrated has been built for the Waelhem fort, and takes two 150-centimeter (5·9 in.) guns. Very complete tests of the plant were made by the authorities last December and January. One hundred rounds were fired from the guns with full service charges, each charge comprising 19·8 pounds of brown prismatic powder and a shell weighing 108 pounds. At the conclusion of the trial the whole of the working parts, including the springs for taking up the recoil, were found in excellent condition. It was ascertained, moreover, that the guns could be trained through 27° in from 25 to 30 seconds. Special attention has been devoted to the ready mounting and dismounting of the guns, one of which can, it is found, be removed and replaced in 65 minutes. The cupola can be rotated at the rate of one complete revolution in 60 seconds, when six men are employed to work the turning gear; four men, it was found, could make a turn in 75 seconds and two men in 150 seconds.—We are indebted to Engineering for the cut and particulars.



ARMORED CUPOLA FOR FORT WAELHEM.

THE PORTUGUESE CRUISER "ADAMASTOR."

THE latest addition to the Royal Portuguese Navy is the twin screw cruiser "Adamastor," which performed her speed trials and was accepted in July last. The ship was built and engined by Orlando Brothers, of Leghorn. Her general dimensions are as follows, viz.: Length between perpendiculars, 242 feet 2 inches (73·810 meters); length over all, 261 feet (79·622 meters); breadth, 35 feet 2 inches (10·730 meters); depth moulded, 21 feet 4⅛ inches (6·500 meters); normal displacement, 1,765 metric tons; displacement, with 419 tons of coal on board, 1,962 tons. The hull is of steel and is partially double bottomed. The whole is divided into twenty-three main watertight compartments, and the lower deck is of steel with watertight doors.

The armament consists of two 15-centimeter Krupp guns, placed one on the topgallant forecastle and one on the raised quarter deck; four quick-firing 10·5-centimeter and four quick-firing 6·5-centimeter Krupp guns on the main deck; two 37-millimeter Hotchkiss guns on the bridge; two 6·5-millimeter Nordenfeldt machine guns on the fighting tops. Besides, there are three torpedo tubes, one forward and two on the broadside on the main deck.

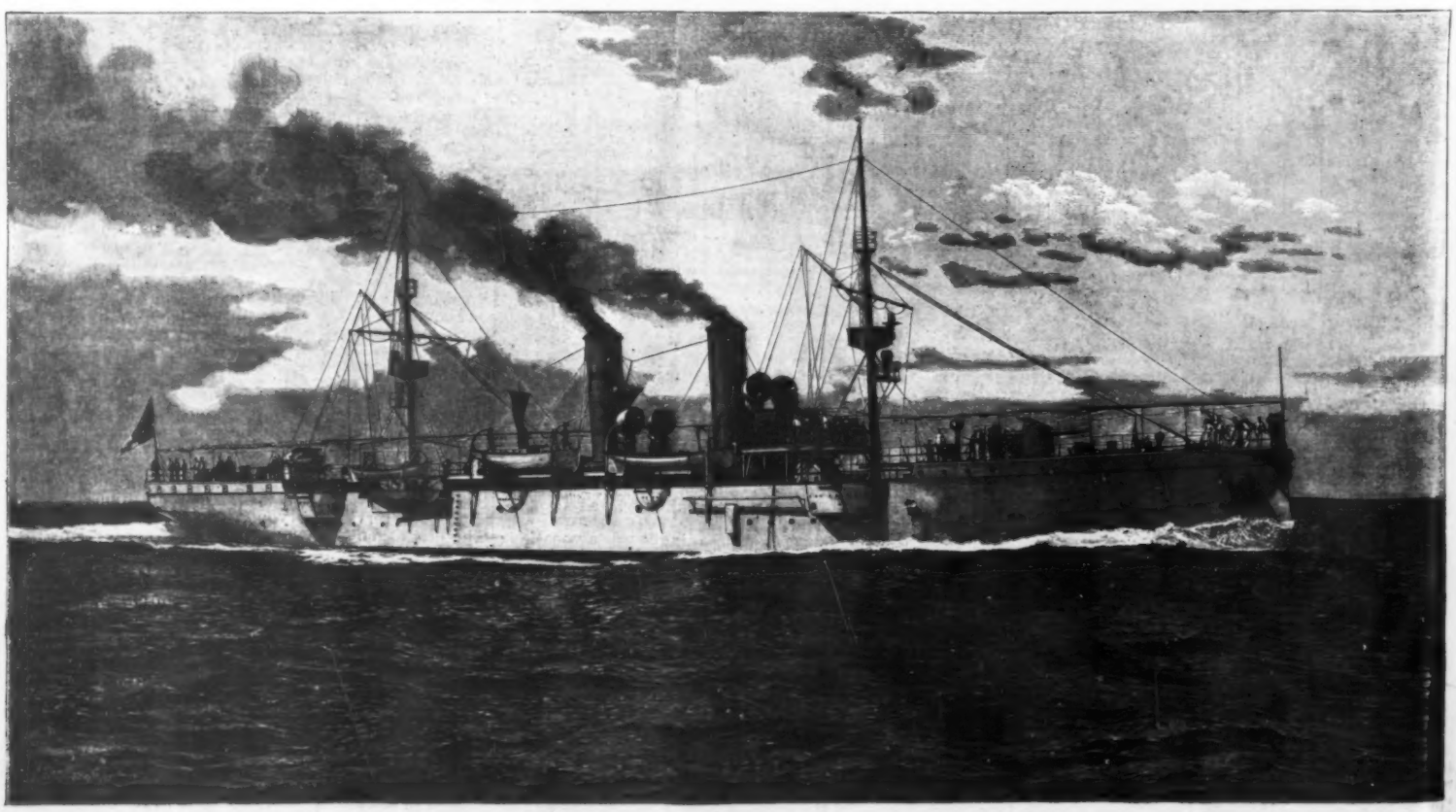
The conning tower is of steel 2½ inches thick. There are six boats, one of which is a steam launch. On the quarter deck there is a very elegant stateroom; the chief commander's bed, drawing and bath rooms; the second commander's bed and bath rooms; the pantry, the chart room, etc. The officers' accommodation is aft, but under the main deck; the officers' mess room, which is near the midshipmen's mess room and cabins, extends the full breadth of the ship. The topgallant forecastle is occupied by petty officers' cabins and sailors.

Great care was taken in ventilating the ship with natural draught; but besides this, two electric ventilators, 4 feet in diameter, are provided for use in hot climates, and they blow the fresh air not only into every cabin, but also into the store rooms, steering engine room and magazines. The vessel is propelled by two triple expansion engines designed to develop 4,000 indicated horse power, placed in separate watertight compartments, the high pressure cylinders being forward; the bed plates, the cylinder frames, which are of the inverted Y form, as well as the covers of the cylinders and valve chests, are of cast steel. The cylinders' diameters are: High pressure, 23¼ inches (0·59 meter); intermediate, 37⅜ inches (0·950 meter); low pressure, 59½ inches (1·500 meters). The common stroke is 31½ inches (0·800 meter). The main condensers are in the wings; they are cylindrical and built with Muntz sheets; the total combined condensing area is 4,862 square feet. The propellers are of Delta metal, three bladed, 10 feet 11½ inches in diameter (3·340 meters), the projected surface of each propeller being of 30·66 square feet (2·85 m.q.). Steam is supplied by four marine single ended boilers placed in separate watertight compartments; they are 13 feet 6⅞ inches in diameter and 12 feet 3½ inches long, with three Fox's furnaces, each 3 feet 7⅛ inches mean diameter. The total heating surface is 8,823 square feet (8·20 m.q.); the total grate area is 262 square feet. The working pressure is 160 pounds per square inch. Four ventilating tubes, 39½ inches in diameter, supply air to the boilers at natural draught, and four ventilating fans, 5 feet 3 inches (1·600 meters) in diameter are provided for the forced draught, which is on the closed ashpit system. One auxiliary boiler, having 223 square feet of heating surface, is placed on the main deck. A very complete system of pumping arrangement is fitted, and we may mention the two 500 tons per hour centrifugal pumps, the bilge and auxiliary pumps, capable of pumping overboard 100 tons of water per hour, and the two 50 tons each steam ejectors.

Three trials were to be made. The contract speed at natural draught, six hours' trial, was to be 16 knots, with 115 revolutions and 3,000 indicated horse power the main engines. The official results of this first trial, made on June 28, 1897, are: Mean speed, 17·19 knots; mean revolutions, 119, with a maximum of 122; indicated horse power varying from 2,900 to 3,100. On the following six hours' trial at 10 knots speed, the coal consumption was not to exceed 154 pounds (70 kilogrammes) per mile. This trial was made on June 30; the power developed by the main engines, running at 67 revolutions, corresponding to 10 mile speed, was 523, and the coal consumption in the six hours was 4,629 pounds (2,100 kilogrammes), that is, 77 pounds per mile, or 1·45 pounds per indicated horse power.

The coal capacity of the bunkers being of 419 tons, the radius of the "Adamastor" at 10 knots speed is at least 8,896 miles, including the coal consumption of the galley, water distilling apparatus, etc.

The two hours' forced draught trial was to give a speed of 17·3 knots with 130 revolutions of the main engines and 4,000 indicated horse power. The trial was made on July 8 (on which occasion the photograph of the vessel at sea, reproduced as our supplement this



PORTUGUESE CRUISER "ADAMASTOR."

week, was taken), with the following results: Speed, mean, 18·04 knots; revolutions, 131·5; mean indicated horse power, 4,030; steam pressure in the boilers varying from 156 pounds to 160 pounds; air pressure in the ashpits, ⅝ inch of water. The engines, as well as the boilers, worked during all the trials in the most satisfactory manner, no part of the engines getting heated, nor was there any priming.

The "Adamastor's" electric plant consists of two 4-pole dynamos, directly coupled to the vertical single cylinder double-acting engines, 8 inches in diameter, with 5½ inch stroke, working at 275 revolutions per minute. The current output of each dynamo is 110 amperes at 65 volts. There are 190 lamps through the ship and two 16-inch diameter 50-ampere searchlights on the mast. The hull and the engines of the "Adamastor" were designed and constructed by Messrs. Orlando Brothers.—The Engineer.

MACHINE FOR THROWING GRENADES WITH GREATER ACCURACY AND TO A GREATER DISTANCE THAN CAN BE DONE BY HAND.

IN the terreplein of a bastion or along the curtain, on the side upon which the besiegers make their attack, there may be placed several of these machines for throwing grenades, and which, being very simple, will cost but little to construct, and will, nevertheless, be of much service in interrupting or retarding the work of the enemy.

This machine is properly only a swing beam provided at the end, A, with a hook, B, and with a bowl capable of holding one grenade, or more if desired, and which is also provided at the end, C, with a box that can be loaded with earth or stones in such quantity as may be necessary. This beam is placed upon the pivot, D, between the two uprights, E and F.

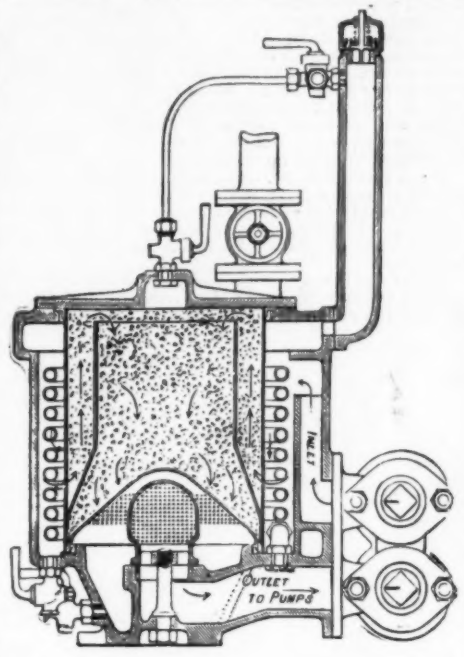
When it is desired to use this machine, the point, A, of the beam is lowered to the large square block, G. This is very easily done, despite the weight with which the box, C, is loaded, by means of the rope, H, and the windlass, I.

The beam being in this position, that is to say, quasi-horizontal, its hook engages with a catch in the block. After it has been thus fixed, the rope, H, which becomes useless and might prevent the execution of the machine, is removed, and the bowl, A, is charged with grenades. After this the fuses of the latter are lighted, and, without any loss of time, the catch of the block, G, is freed. Then, as the hook, B, no longer holds the end, A, of the beam, the latter is free to play; that is to say, the end, C, of the beam being more heavily loaded than the end, A, the latter swiftly travels from the point, G, to the point, K, where it is arrested by the rope marked L. So, by this motion, which resembles that of a sling, the end, A, of the beam throws the grenades contained in the bowl to a greater or less distance, according as the box, C, is heavier or lighter, and throws them certainly much farther than can be done by hand.

Supposing that the grenades that it is desired to throw at the enemy have been cast in moulds of the same size, that they are loaded with the same charge of powder and that they are, consequently, all of the same weight, I say that this machine will always throw them very accurately to the same place, because its stress will always be equal, and that, according to this undoubted principle, having taken your measures during the day, you can discommode the enemy during the entire night without seeing him, and prevent him from advancing his works. If, through the experiments made during the day, you find that your grenades do not go far enough, you will put a greater weight of material in the box, C. If they travel too far, you will lighten the box, and, in order to send them more to the right or more to the left, you can easily point your machine by changing the position of the side posts, E and F. So, having observed during the day where the head of the enemy's trenches is and the places where you judge that he is to throw up some work, you will throw grenades thither during the entire night and prevent him from working.—From Recueil d'Ouvrages Curieux de Mathematique et de Mecanique, 1733.

THE CLINKER FILTER.

OF late years, says The Steamship, numerous types of filters and feed water heaters have been brought out,



and in the accompanying illustration we show one of the latest, and which is being introduced by the Bromell Patents Company, Thomas Street, Liverpool. The getting out of grease from feed water is a matter of first importance, and in the apparatus under notice the use of cloths, felts, flannels and such like has been avoided, the filter being packed with crushed clinker, passed over a sieve to get rid of ashes and dust, and well washed. After use it is emptied on the stokehold floor, and a fresh quantity put into the filter case. The filter case is made of light galvanized steel, and being simply held in position by the outer lid, can be removed and replaced in a few minutes. The suction area through this case is very large, and the water has to pass between its outer and inner shells and down through the inner mass of the filtering material. Provision is made for separating and carrying off to the condenser any free air that may be brought into the filter along with the water. The filter may be occasionally cleaned, and the dirt and grease blown out though the drain cocks, by shutting off the feed water and opening the steam connection to the interior of the filter; but it is recommended that the filtering material be changed at regular intervals. The feed heater, which may or may not be combined with the filter, consists of a series of pipes in the outer casing, of horseshoe form, supplied with steam from the evaporator or other convenient source. The filter is the invention of Messrs. Kincaid and Crockatt, of Greenock and Glasgow, and the sole makers of the apparatus are Messrs Kincaid & Company, engineers, Greenock.

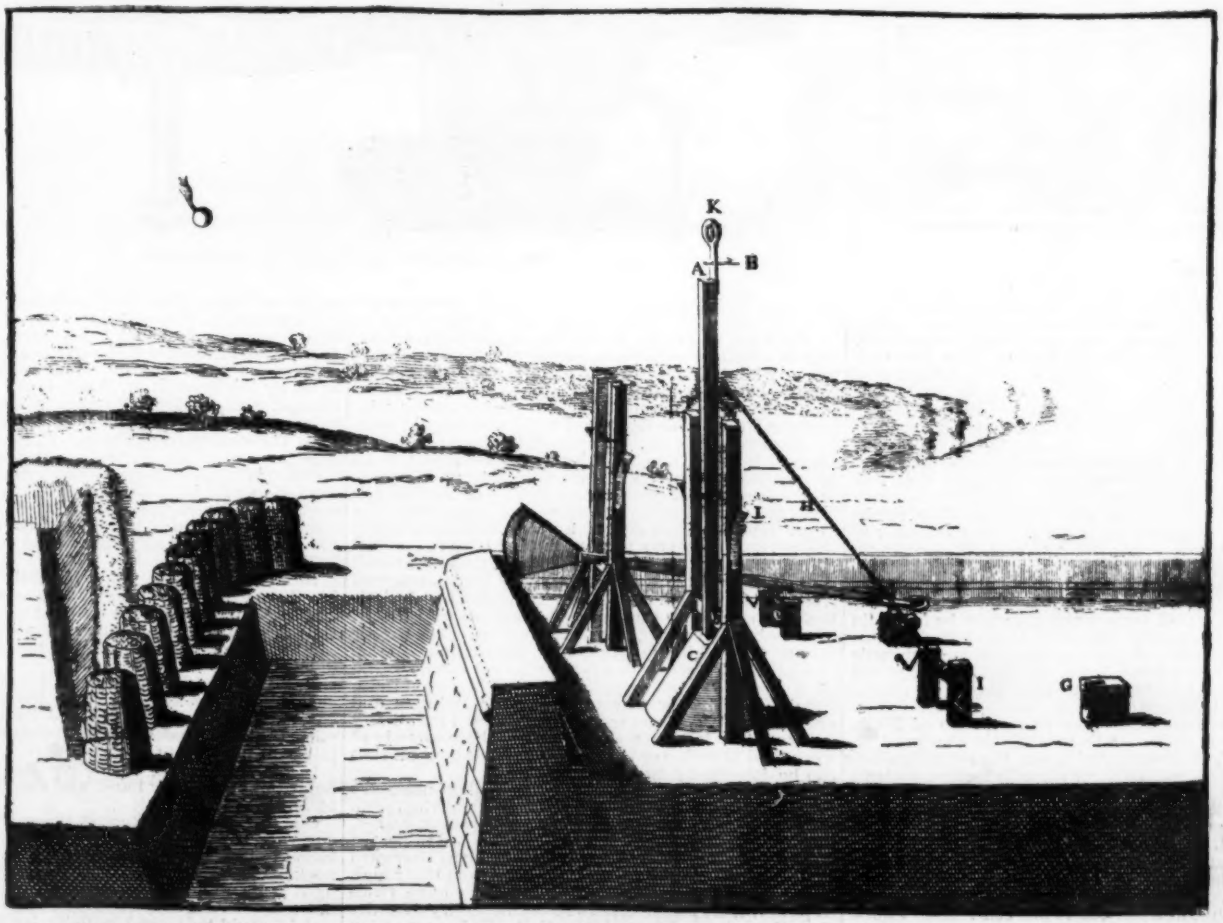
A COURSE OF INSTRUCTION IN ROAD BUILDING.

A MOST excellent departure has been made in Rhode Island, where a course of instruction in practical road building has been instituted in the Agricultural College, at Kingston, and the papers announce, with justifiable exultation, that "this State leads the world" in such an undertaking.

The course of instruction is to extend over two years, and has been laid out after consultation with General Stone. In the class room theoretical instruction will be provided, and the road making plant of the college will furnish ample opportunity for the acquirement of practical knowledge. Students who wish to enter the course must be well grounded in the common branches, including algebra and geometry. During the first year the course will include higher geometry, trigonometry, surveying and other English studies. In the second year, physics, electricity, physiography, geology, mineralogy and steam engineering will be taken. The practical work will run side by side with the theoretical during the course. It will include actual work on the roads, handling the shovel, driving horses, running the stone crusher, traction engine and road roller and all machinery operated by the department. The student will thus actually perform all the varied operations connected with road building, as well as receive competent instruction in all that pertains to the art. In this way not only will a large number of young men receive most valuable training, but a demand will probably quickly arise for special instruction for older men, who now are superintendents of streets, commissioners of highways and engineers.

There is here a field which is not crowded, or even full. As The Providence Journal remarks, "Of late years there has been a demand for competent road builders all through the States that have been constructing macadam highways. In most instances, either theoretical engineers or highway superintendents have risen to fill the places. And to the sorrow and costs of the big cities and the disappointment of the counties, in many instances, the latter have been compelled to pay for the lack of practical knowledge of the civil engineers and the lack of theoretical knowledge of the highway supervisors.

"But, even with this school of men, who have been educated by building the roads, there have not been enough to go around in all the localities where good roads are needed, and where there is money to build them. A man who thoroughly understands road construction to-day may easily get a position. What is



MACHINE FOR THROWING GRENADES WITH GREATER ACCURACY AND TO A GREATER DISTANCE THAN CAN BE DONE BY HAND.

needed is the educated man, who not only knows how to build a costly, ideal road, but one who can economically construct an eight foot country road—a man who knows both the theoretical and practical end of road construction. This is the style of graduate which the Rhode Island institution aims to turn out. . . . At the end of the course they will have graduated a man who can plan the highway, draw the contracts and who is able to run the machinery to build the road; a man who knows the business from the hoe handle to the tripod, from shoveling coal under the boiler of the steam roller to drawing the plans—a road engineer. . . .

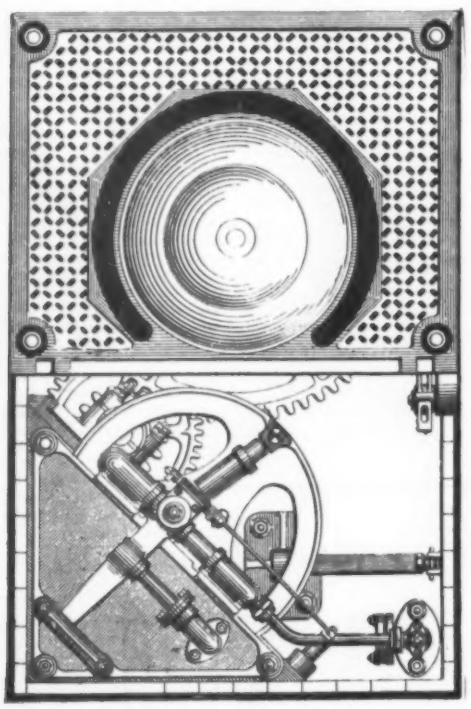
"There are a number of openings which a practical road builder may fill. He may become a road expert for the United States government. By passing the civil service examinations of the Road Division, Department of Agriculture, he will be put on the list of eligibles, and as soon as a vacancy occurs will receive an appointment from the government. Then the builders of road machinery have a constant call for men to set up their plants in the various towns and cities which are constantly acquiring such equipments. They have to send with the machinery men who know all about operating it. As a rule, the men they send out are shop hands, and beyond the rule-of-thumb experience with these identical machines, they know but little. The builders say there is a constant demand for road builders with these plants, and that they consider that this is a good field for young men.

"But the largest field for men educated as road builders will probably be found as highway superintendents among the various counties and towns. There are few first class men in this line and, with the spread of the good roads movement, the demand for such experts is growing."

A HYDRAULIC ENGINE.

By Mr. ARTHUR RIGG.

ALL users of hydraulic power are aware that its cost is greatly enhanced by the wasteful manner in which pressure water is applied. Indeed, the hydraulic engine has been in much the same condition as regards its economical working as the steam engine was before expansion was introduced. Water pressure obtained artificially from steam power by pumping, and then distributed through many miles of high pressure mains, must necessarily be more costly than steam used direct. This would be the case were it applied in an economical manner, and its duty performance maintained at a proportion of say 80 per cent. Such, however, is very far from being the case, not that hydraulic engines working under their full load are in themselves extravagant motors, but because they are handicapped through having to use the full quantity that their cylinders contain, whether working at full power, at half power, or driving themselves alone.



The diameters of their cylinders, like their stroke and revolution, are constants; and such governing as exists simply means throttling the supply, that is, reducing the working head and wasting all such balance of power as cannot be employed in performing useful work.

Such exaggerated extravagance cannot be found in even the worst steam engine, with steam entering during an entire stroke—for steam, after passing a throttle valve, does retain some force, owing to incompleted expansion; but nothing of this kind favors an incompressible fluid such as water.

The cost of pumping water to a pressure of 700 lb. per square inch varies but little, while the charge by hydraulic supply companies varies from 1s. per 1,000 gallons to 2s. per 1,000 gallons for hydraulic motors, under a sliding scale of rates. Indeed, the cost of working such hydraulic engines as are now in the market very much restricts the use of this convenient and serviceable source of power.

One thousand gallons of water per hour, falling 1,600 feet, or having its equivalent pressure of 700 lb. per square inch, may be taken as giving 8 horse power gross; and this, at a duty of 75 per cent., gives 6 horse power net. Taking the cost of pressure water at 1s. per 1,000 gallons, the cost of 1 horse power per hour is 2.1., a figure which agrees with that given by Mr. Ellington in his paper on "Hydraulic Supply," read before the Institution of Civil Engineers in 1888, and he continues, "In no case would it be profitable in London to supply power at less than 3d. per horse power hour. . . . . At current rates . . . . . the cost of working is too high for continuous driving, and the hydraulic engine is itself not a sufficiently economical machine to induce a large use. What is required is a good durable engine, with an automatic regulation of the consumption of power water, at a constant speed according to the varying demands on the engine." If, therefore, 20 horse power be obtained at this rate by a hydraulic engine working always at full power for 1,800 hours, the cost of pressure water becomes £300. But as very few hydraulic engines are required to give out their full power continuously, although always consuming the full value of an equivalent water expenditure, this condition of things further exaggerates the cost of power obtained through water at high pressure artificially produced.

Assuming an engine that is required to give out 20 horse power at starting its load, but working, as many do, for the remainder of their time at an average of 10 horse power. This at once doubles the rated cost of 10 horse power by making it equal to the expenditure for 20 horse power; or taking a continuous value for 1,800 hours and 20 horse power at £300 = the cost of 10 horse power, comes out the same, £300, which would be reduced to £150 in a properly governed engine.

It can be no wonder, then, that ever since 1848—fifty years ago—when Lord Armstrong first introduced his hydraulic rotative engine, attempts innumerable have been made to invent one that shall alter its piston displacement in proportion to variations in the demand for power.

In the whole range of commercial enterprise connected with engineering it would be hard to find anything to beat the record for extravagance now held by un-

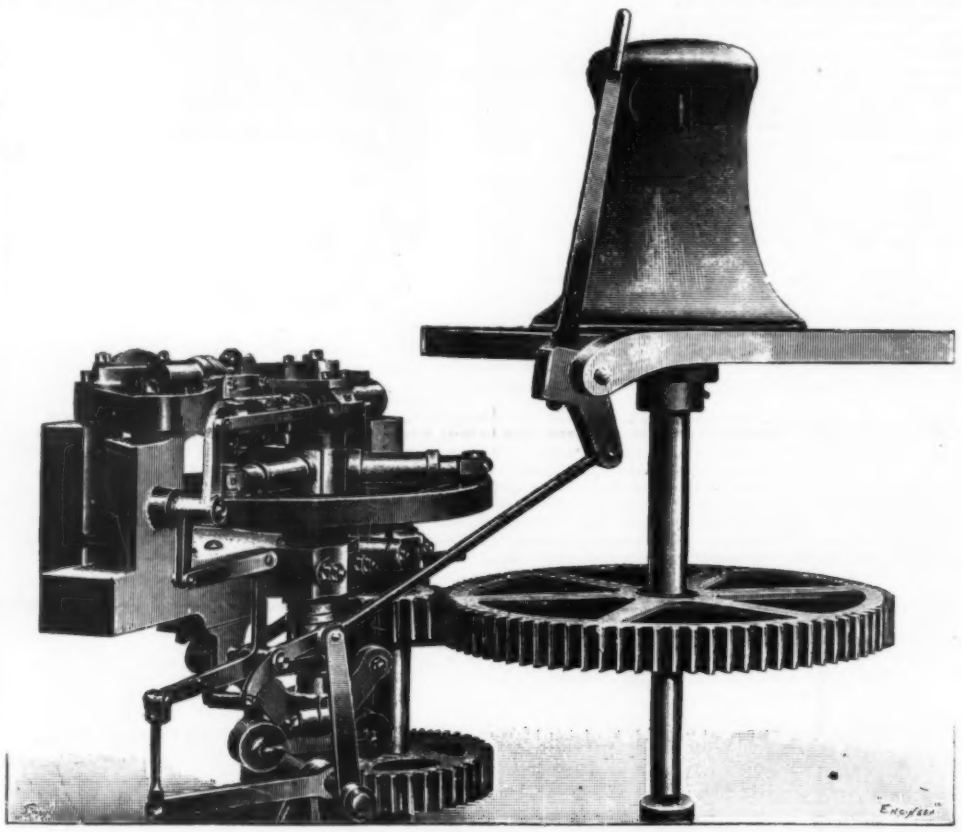


FIG. 1.—RIGG'S HYDRAULIC CAPSTAN.

governed hydraulic engines. This is not due so much to any defect in the principles of their construction as to the want of proper governing, aggravated by the way in which such engines are expected to run without any kind of lubrication for their internal parts. Nobody ever expects a steam engine to work well under such adverse conditions, and the engine driver who neglected to use his sight feed lubricators would soon be dismissed his post. Yet the same kind of neglect attracts no attention with hydraulic engines now in general use. Such engines when working at full power, and capable of performing a duty of say 80 per cent., are worked under conditions so barbarous that 60 per cent. becomes a good average, and the engines themselves receive no more attention than sailors bestow upon steam capstans. Considering, too, that such engines frequently draw their supply from unfiltered river water, or from the impure contents of a dock, it is almost surprising that so good a duty as 60 per cent. can be obtained under any circumstances. The proper system for working any hydraulic installation is to return all exhaust water to a tank, where it can be warmed if necessary, and supplied with a lubricant; also enough fresh water to compensate for leakages and evaporation. This can readily be arranged for all new systems, but it is not so easy with those already at work, and filtration of the water remains about all that can be done under most circumstances.

Experiments made to ascertain the haulage necessary to start a load, and then to keep such load moving, seem to show that for such examples as capstans, cranes, drawbridges, grain elevators, etc., about double the strain is needed to start such loads moving as afterward suffices to keep them going. Judging from this rough rule, it becomes necessary to provide an engine twice as powerful as would otherwise be necessary in order that there be no failure in starting. This proportion would mean no loss in the case of an engine governed so as to reduce the stroke by one-half after the load begins to move; but it leads to incomparable extravagance with such engines as are now in general use, not governed at all.

This extravagance means a very great deal in connection with capital expenditure upon boilers, engines, and accumulators, for all of which covered space has to be found and interest earned. As the ordinary type of hydraulic crane possesses the same kind of defect that accompanies the rotative engines, and as the first opening of lock gates absorbs more power than their future movement, it may very well be taken that half the power now supplied is absolutely thrown away. This, in a large dock, means the loss of many thousands a year from preventable causes, and means a pitch of wasteful extravagance of which makers of the very cheapest type of steam engines would be thoroughly ashamed.

In the good old times, when income was plentiful, matters of economy received only scant attention, but such neglect can now no longer be tolerated in these days of competition. No accountant is needed to prove that a saving of 50 per cent. annual expenditure would justify the entire renewal of any plant, just as they would certainly do in America for considerably less gain. The adoption of compound pumping engines has cheapened the cost of pressure water, to the advantage of shareholders in any hydraulic supply company, but what concerns the consumer most is the economical production of power from water delivered to him.

It will be interesting at this stage to trace the progress of several inventions that have had for their object the economical regulation of power by hydraulic motors. The earliest idea seems to have been that patented by Messrs. Knowlden and Edwards in 1858. Three cylinders, set at 120° apart, were all arranged to drive the same crank, which was on a stroke that could be altered as to radius by two hydraulic rams. These were moved by pressure conveyed through pipes in the middle of the engine shaft, and thus the stroke could be regulated while the engine was running. The same idea has occurred to other inventors, but the system does not seem to have made any headway.

Another type of variable power engine was that patented by Mr. Percy S. B. Westmacott, a member of the Elswick firm, in 1863. In this, a somewhat complex valve arrangement was adopted for using a selection from three rams and pistons. If, for example, an engine have rams 2¾ inches in diameter and pistons 4 inches in diameter, then by admitting pressure under the 4-inch pistons, while the opposing annulus is open to the atmosphere, the engine works to its full power. Again, if a constant pressure be upon the annulus, and the 4-inch pistons are working as before, then only half power is given out.

In 1874 Mr. Andrew Brown, of Edinburgh, described his three-cylinder hydraulic engine, which was regulated in a somewhat intermittent manner, by moving the crank pin into holes of different radii; but this arrangement was quite unsuitable for automatic governing.

Mr. Hoppé, of Berlin, governs his hydraulic engines on a different system, whereby low-pressure water in varying quantity, as determined by a governor, is admitted to the cylinder, and all remaining space becomes filled with water of the higher working pressure.

In all these cases, except the last, regulation is intended to be done by hand, and therefore it is unreliable, or practically useless.

One of the earliest engines possessing an automatic governor to regulate the quantity of water used in relation to load was that of the late Mr. Hastie, of Greenock. It was specially designed for hoists—to run light loads up quickly, with a shortened stroke, and to move heavier loads more slowly. His crank pin, set in a slide, could be moved radially by cams attached to the winding drum, which turned round in relation to the engine shaft as the resistance varied. The drum

was held forward by springs, like those of a dynamometer pulley, and it was arranged for the crank pin to move in its slide and give an increased stroke whenever resistance became greater. This engine, however, possessed no timing arrangement, and can hardly be considered complete as a governed engine. The same remark applies to all the other systems described, for none of them comes up to the ideal of perfect governing; that is, maintaining an approximately uniform number of revolutions, however much the load may change. Of all methods for regulating the quantity of water expended, none is simpler than altering the ra

levers, not shown in the figure, having also its valves carried upon the moving head, like the valves of a steering gear are carried. This simple arrangement gets rid of any tendency toward hunting; because as the governor balls extend or contract so does the stroke diminish or increase, just as if they caused the movement directly. The main driving engine consists of three cylinders, revolving round a stud, which is carried by the relay, and of three rams which are carried by three crank pins projecting from the face of the fly wheel, and always, therefore, turning round upon its center; which is that of the main shaft. As

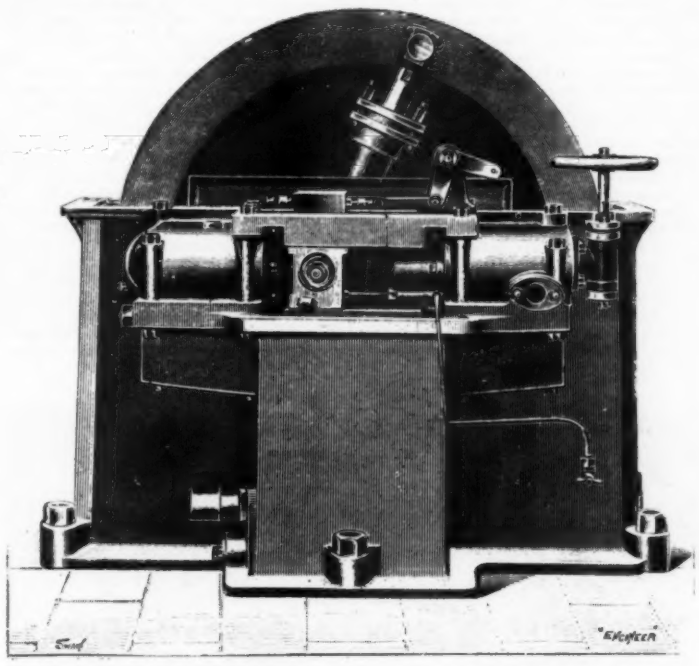


FIG. 2.—RIGG'S HYDRAULIC ENGINE.

dius of one crank, around which are fixed any convenient number of cylinders. Varying the radius of an ordinary crank while the engine is running, although it can be done by means of hydraulic rams, according to the system of Messrs. Knowlden and Edwards, is so uncertain and cumbersome as to be practically unworkable with engines of the usual type.

There is, however, an inversion of the ordinary type of engine, where the crank does not turn round, and the cylinders revolve around it. Thus the crank radius can be altered as desired while the engine is running, and up to the present it is only engines of this type which can be governed to use pressure water in due proportion to work done, and to make approximately the same number of revolutions, however much the load may change. Two examples of this class of engine, the invention of the writer, are shown by illustrations, Figs. 1 and 2. Fig. 2 shows the front elevation, with cover removed, of an engine driving a large grain elevator, which requires considerably more power to start than to keep going. This elevator can be driven by its original motor, an Armstrong engine of the usual three-cylinder type, or by Rigg's engine, so the performances of both can easily be compared. At starting either engine provides about 20 horse power, and the older type uses pressure water up to this value all the time that it is running.

Very different, however, is the result obtained by the newer type, for, as speed increases, the governor begins to act, and reduces the stroke to such an extent that while raising oats 8 horse power only is required, thus effecting a saving of 60 per cent. in the amount of pressure water that would be required to drive any ungoverned engine. In the event of an insufficient feed to the elevator, then the governor balls extend and shorten the stroke, so reducing the expenditure of pressure water to 4 horse power, while the attenuated exhaust water emphasizes the value of the mechanical contrivances that can and do effect a clear saving of 60 per cent. to 80 per cent. of the water power.

This hydraulic motor actually comprises two separate and distinct engines; one of these drives the load, while the other engine serves as a "relay," having its valves worked by the governor through rods and therefore the relay engine answers all movements of the governor ball, so does the stud, which carries the cylinders, approach or recede from the main center, and so this distance, which corresponds with the crank of an ordinary engine, alters accordingly. An oil pump is supplied with all these engines to lubricate the stud around which the cylinders revolve, and there are many minor details which go to perfect this construction, and to enable it to endure the hardships of ordinary work.

In reference to the amount of power required to start a load, and thenceforth to keep it moving, a very interesting experiment was made with a drawbridge, which is now moved over and back from a dock entrance 72 feet wide by one of these engines similar to Fig. 1. But it has no governor, and is arranged to reverse, varying the power in either direction, according to the control of the attendant. It was found that a pull upon the steel rope of three tons was required to start this bridge, but that a pull of from 30 to 35 hundredweight sufficed to keep it moving; so this case would indicate that an engine with variable stroke would be in a position to economize half the water required for any hydraulic engine with a fixed stroke doing this work. It is not easy to ascertain such data as this very often, but a proportion of 50 per cent. seems generally applicable to capstans and hydraulic power generally, wherever an automatically governed engine is used, instead of one that consumes the full value of water always.

Figs. 1 and 3 illustrate by a plan and photograph one of Rigg's governed hydraulic engines driving a three-ton capstan recently erected in London. The bollard, of cast steel, has been designed after examining many and noting their defects and good features. Gearing permits the use of an engine of comparatively small size, and allows the main shaft to take its bearing in a strong bedplate, while the engine becomes open, and most easily accessible. The governor is carried lower down upon the crank shaft, and it acts through levers and rods upon the relay engine valves, which are clearly seen in the plan. Whenever water pressure is admitted to the engine—which stands at full stroke—movement increases until the governor balls extend, and act upon one of the two valves of the relay, which at once responds to this direction, and shortens the stroke, perhaps to about one-eighth of the full amount, thus saving about 85 per cent. The bollard, moreover, can never "run away," and directly that it feels the rope the governor balls close together, and subsequently keep altering the stroke all the time that haulage proceeds, using just so much pressure water as may be required for the present load, and saving, on an average, at least one-half of the pressure water demanded for similar work by any ungoverned hydraulic engine. The handle alongside the bollard is only intended for occasional use, reversing the engine, if, for example, a new rope develops a kink, and cannot be cleared without a reversal. Some engineers prefer to avoid the use of gearing, and in such case there is no difficulty whatever in the application of larger sized engines, working direct upon the main shaft. One of these variable stroke hydraulic engines has been at work for seven years working wagons up inclines, another nine years driving chain pumps, etc., without requiring any renewals, except packing rings, and although to anyone unfamiliar with the arrangement it may appear complex by comparison with an ordinary hydraulic engine, yet nobody can expect to effect a saving of 50 per cent. without some extra machinery to do it with, and it must be recollected that every detail of this mechanism serves a very definite purpose.

As with all other machines, it is only necessary to be sure that each part has been properly proportioned to guarantee that the whole shall fulfill the purposes of the inventor, who designed all these machines, and of Messrs. Hughes & Lancaster, who made them.—We are indebted to The London Engineer for the cuts and particulars.

THE NEW PALACES OF THE CHAMPS ELYSEES.

THE construction of two new palaces designed to replace the Palace of Industry and the Pavilion of the City of Paris, at the Champs Elysees, is going to give rise to a curious experiment.

As well known, the Great Palace did not rise all of a piece from the competition of 1896, the various leading projects having, after a manner, been blended. The final structure will therefore be due to the collaboration of several reputable architects, each of whom, moreover, will have had an opportunity of exercising his own peculiar talent in that part of the edifice assigned to him.

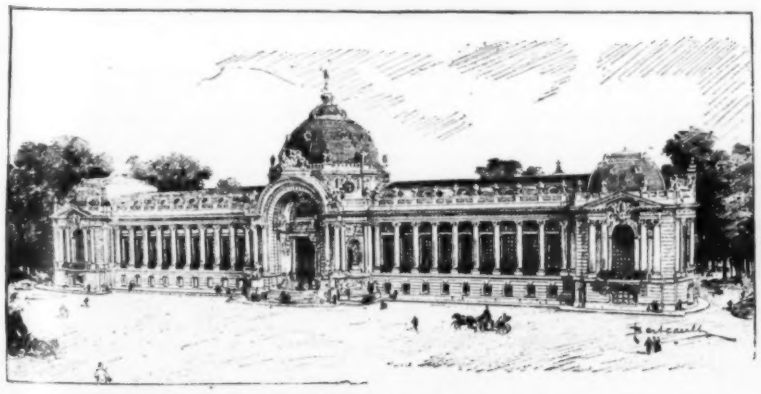
It is none the less true that, while the Great Palace will not be the Louvet Palace, nor the Deglane Palace, nor the Thomas Palace, the Small Palace will be called the Girault. In fact, M. Girault's project, which obtained the first prize, is in course of execution without any appreciable change.

To the right of Avenue Nicolas II we shall therefore have a great composite palace, the result of a skillful collaboration, and, to the left, a small palace conceived and constructed by one and the same artist. Experience will tell which of the two systems is the better.

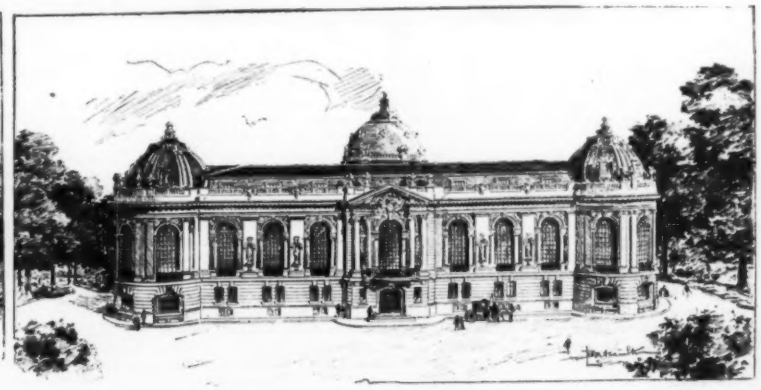
The Small Palace covers a quadrilateral in the form of a regular trapezium, the longest base being parallel with the new avenue. A plaster model which has just been finished will show how well M. Girault has succeeded in turning the configuration of the ground to account. At the center of the principal façade there will be a large bay of 15 meters opening, which will be reached through twenty steps and which will be surmounted by a cupola. To the right and left there will be two series of Ionic columns, and at each extremity there will be a wing. The central cupola will cover a vast vestibule of slightly elliptical form, flanked by two large exhibition halls lighted by windows that occupy the spaces between the columns.

The two lateral façades will be connected by a sharp angle with the main façade, which will make an obtuse angle with the posterior one. The three secondary parts of the building will comprise a series of galleries lighted by windows looking out upon the groups of trees of the Champs Elysees. In the center of the structure there will be laid out a garden bordered with a semicircular peristyle, the level of which will be raised four meters above the mean level of the external earth. Between the peristyle and the main buildings upon three sides of the edifice internal galleries that receive their light from above will line the external ones. The foundation, despite the difficulty met with in the search for good ground on the side of the Seine, was finished in less than three months, and the first courses have already appeared above ground. The masonry should be finished before the end of October, 1898. Even if the heavy work is finished within this time, it is certain that the sculpture of the Girault Palace will not, any more than will that of its great neighbor, be completed for 1900. Mouldings in staff will provisionally supply this want.

Let us recall the fact that the Small Palace will be



PRINCIPAL FAÇADE OF THE SMALL PALACE OF FINE ARTS.



POSTERIOR FAÇADE OF THE SAME PALACE.

M. GIRAULT, ARCHITECT.

used for the retrospective exhibition of art, and that it will afterward become the property of the city of Paris, which will place therein the pictures and statues that are annually coming into its possession.—L'Illustration.

THE BANK OF FRANCE.

THE Reign of Terror was scarcely over when several banking houses were founded at Paris, and, among others, the Caisse des Comptes Courants, which on February 13, 1800, took the name of Bank of France and was converted into a joint stock company with a capital of thirty millions divided into 30,000 shares of 1,000 francs each. The government took 5,000 of these shares and the bank began operations on February 20. Nevertheless, although a state bank (since it had in charge the paying of the annuities for which the government was responsible), it was not until April 14, 1803, that it received the exclusive privilege of issuing bank notes for a period of fifteen years. Three years later, the privilege was extended to twenty-five years, and, at the same time, the executive power of the central committee was vested in the hands of a governor, assisted by two subgovernors, all appointed by the state. In 1808 a new law ordered the creation of branches in the country, and in 1857 it was decided to establish a branch in each department.

The present governor of the Bank of France is M. Magnin. He is assisted in his duties by two subgovernors, fifteen regents and three censors. The stockholders who take part in the general assembly are two hundred in number. The capital of the bank, after greatly varying, is now 182,500,000 francs. The principal operations of the institution consist in discounting bills of exchange and other commercial paper at sight and at the expiration of different lengths of time, but not exceeding three months; in opening current accounts with bankers and private individuals; in making advances of money to the public against the deposit of certain securities—such as paper, bullion or foreign gold and silver; and in receiving deposits of bonds, etc.

The employés of the branches, auxiliary offices, etc., number about 1,300. The bank itself, at Paris, employs a thousand agents, nearly two hundred of whom are women. The bank manufactures its own bills from special paper supplied by the works that it owns at Biercy.

It would not be suspected that an establishment of this nature could contain artistic riches. The Bank of France, independently of its famous vaults, in which millions are heaped up, possesses another treasure which bears the name of the "Galerie Dorée." This structure, the last vestige of the old Hotel de Toulouse, which stood upon this site, is reckoned among the fine works of the age of Louis Quatorze.

The Hotel de Toulouse, previously called the Hotel de la Vrillière, was constructed after the drawings of François Mansard, in 1635, by Louis Phelypeaux, Sieur d'Herbault, secretary of state. This dwelling was one of the most curious in Paris, by reason of the large number of pictures and statues that it contained. The celebrated hall that, according to custom, is called the "Gilded Gallery" was finished in 1719 with the cooperation of Robert de Cotte, the king's chief architect.

This superb gallery is 40 meters in length by 6 in width. It owes the regularity of its proportions to the genius and skill of François Mansard, who, finding himself embarrassed at one of its extremities by the meeting of Rue Neuve-des-Bons-Enfants (now Rue Radziwill), took it into his head to remedy the trouble by an overhanging projection upon the street, in order, by this means, to obtain the width necessary.

Six large arched bays, corresponding to as many arcades filled with mirrors, regulate the ordonnance of the architecture. All the ornaments of sculpture, of wonderful finish, are by Vassé. They represent warrior attributes and marine and hunting scenes carved in oak, and form the larger part of the decoration of the gallery. The ceiling of the latter consists of a surbased arch which François Pervier painted in 1645, on his return from his second trip to Italy. He divided this space into five large pictures. Apollo or the Sun is represented in the central painting of the vault, and the elements form the subjects of the four others. The god of day is preceded by Aurora and by small Zephyrs occupied in sprinkling the morning dew, and is accompanied by her ordinary cortege. Night reposes in one corner of the picture, and is awakening in measure as she feels the approach of the Sun. The Earth and Fire are designated by the rape of Proserpine and by Pluto, and by Jupiter in the full splendor of his majesty, on his way to visit Semele. Juno beseeching Aeolus to unchain the winds represents the Air. Neptune and Thetis represent Water.

The window piers, decorated originally with pictures of the greatest masters, since distributed through various museums and replaced by faithful copies, represent such scenes as the Death of Cleopatra, Coriolanus overcome by the Tears of his Family, Romulus and Remus brought up by Faustulus, Rape of Helen, etc.

Over the entrance door, opposite the monumental chimney piece of Savancolin marble, decorated with tritons and ornaments of gilded bronze, smile Diana and her companions, surrounded by satyrs and women frolicking with birds of prey.

The mirror that surmounts the mantel is in a single piece. As for the clock, that is a gift made by Baron de Rothschild, at the close of a session at which the members of the general council of the bank expressed the regret that they had not the time. Above the cornice there is an allegorical figure of the Navy, in the guise of a richly clad female, forming a group with the prow of a vessel laden with horns of plenty, and escorted by winds and trophies, and surrounded by groups of tritons bearing attributes of the admiralty.

The Duke of Penthierre, son of the Count of Toulouse, caused the removal of the buildings bordering upon Rue de la Vrillière as far as to the meeting of Rue Neuve-des-Petits-Champs. At his death his estate was declared national property and the hotel became the seat of the printing office of the Bulletin des Lois and the Republique for thirteen years. After the artistic wealth that had accumulated here had been removed to the recently created museum, all the emblems of the extinct regime disappeared. The gilded gallery did not escape the devastation, because it was the intention to make a paper warehouse of it.

On the 6th of March, 1808, the Hotel de Toulouse and its dependences were, by a decree, ceded for two millions to the Bank of France, which was then established in the Hotel de Massiac, Place des Victoires. In the month of January, 1812, the assembly general of the stockholders was held for the first time in the Galerie Dorée, which has ever since then been used only for such meetings.

Along about 1854 it was noticed that Mansard's work was threatened with ruin, and four years later it was decided to reconstruct it. M. Questel, architect of the Palace of Versailles, was put in charge of this delicate task. Begun in 1870, and interrupted by various events, the work was finished at the end of 1875. The old foundations were found at 8 meters below the surface of the ground, on Rue Radziwill. They were established upon piers and washed by a stream that flowed in the moats of the ancient wall of Charles V. As the presses of the bank's printing office now occupy the ground floor, which was the Marquis de la Vrillière's orangery, the principal façade presents a somewhat different aspect from that which Mansard gave it. In the interior, on the contrary, all that remains of the work of Robert de Cotte has been scrupulously respected, and an endeavor has been made to reproduce, as exactly as possible, all of it that had disappeared. The four oak statues placed in the niches, at the extremities of the gallery, and representing the four parts of the world, are due to the chisel of M. Thomas, of the Institute. The other collaborators of M. Questel are MM. Raulin, Vernaud, Balze, Denuelle, Cruchet, Gilbert, Parfoury, Lemaire, Bocquet and Christofle.

The bank, in causing the restoration of the Galerie Dorée, which is of no practical utility to it, has proved the interest that the preservation of this renowned work presents for art.

THE GILDED GALLERY OF THE BANK OF FRANCE.

For the above particulars and the illustration we are indebted to the Magasin Pittoresque.

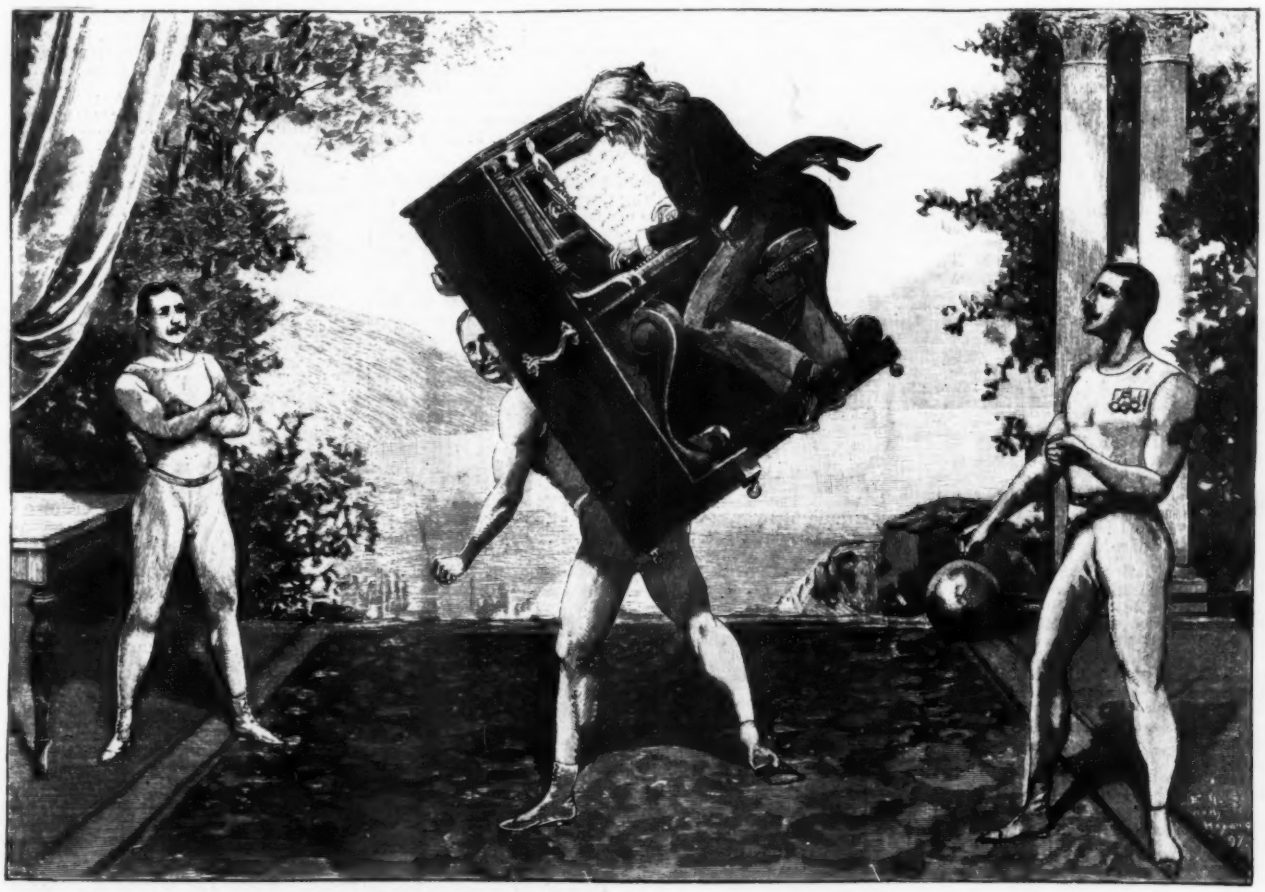
ELECTRIC ARC INJURIOUS TO EYESIGHT.

ONE effect of the advent of the X ray has been to direct closer attention to the influence of the electric light on the eyesight. It has recently been stated, says The Chemical Trade Journal, that sailors suffer much in their eyesight from the brilliant electric lights used on shipboard. Gray and blue eyes are the most subject to injury, not being heavily charged with pigments. The men who work the searchlights already wear dark blue glasses, but it is found that these only mitigate the intensity of light, and do not absorb the source of the trouble, the ultra-violet rays. These rays, however, can be intercepted by goggles or screens of uranium, on yellow glass, and with these, it is understood, the sailors of the French navy are soon to be provided. Another interesting case bearing on this subject is reported from a British warship. It seems that two stokers on the ship, having a little spare time, became engrossed in the operation of an electric drill, which was burning out holes in a hardened steel plate. Both men declared they only watched the arc for about three minutes, and at the time felt no ill effects, except that all objects appeared to be of a deep gold color. At night, however, both men were aroused by intense pain and partial blindness for the time being, but both recovered quickly after treatment. The electric drill acts by fusing a hole through the steel, and the intensity of the light is greatly increased by the rays of light thrown off by the molten metal. The fact, too, that the work is carried on chiefly in the daylight

is apt to deceive the casual onlooker as to the degree of brilliancy of the light, and it is not until the after effects begin to assert themselves that he is aware of anything out of the common. Dark glasses are now used by all the men on the electric drilling shifts. A singular feature of this affection is that it is analogous to snow or desert blindness, and, as in them, the pernicious effects of the electric light are probably due to the ultra-violet rays of the spectrum.

AN ATHLETIC FEAT.

AN exhibition of great physical strength has a strong attraction for all classes of people. Not only men, but women also are interested in seeing athletes play shuttlecock with gigantic weights on the stages of the so-called variety theaters, for spectators take great satisfaction in watching a demonstration of the fact that by energy, persistency and endurance a fellow being can gain sufficient strength to lift colossal burdens, completely mastering inanimate matter. Such exhibitions are generally based on some trick. Formerly a great athlete would lift a live horse and later they practiced lifting an entire piano and carrying it about, but the latest trick is to lift, not only the piano, but the performer too, and walk about with both. An "artist" of this kind appeared recently in Berlin whose feats were truly astonishing. He certainly did not hold the piano at arm's length, but took the greater part of the burden on his right shoulder, which he arched so as to get a support. Some of these athletes are careful to have a slight projection on the back of the piano where the shoulder will come, which makes it easier to hold



AN ATHLETIC FEAT—LIFTING OF A PIANO AND PERFORMER BY THE ATHLETE APOLLON, IN THE REICHSHALLEN THEATER, IN BERLIN.

the terrible weight. But, in spite of any such precautions, this feat requires a most extraordinary amount of strength, and the athletes are exhausted after the exhibition, which lasts a comparatively short time. An exceptionally regular life, uninterrupted practice and a straining of all the energies to this one purpose is required to give a nightly performance of this kind. —Illustrirte Zeitung.

THE MODERN NOVELIST AND MEDICAL SUBJECTS.

ERRONEOUS statements on medical subjects are very frequent in the modern novel, and appear to be becoming more so, says The Medical Record. Impossible and contradictory descriptions of the symptoms and course of a disease, together with a display of ignorance of medical matters in general, are a feature of up-to-date fiction. One would imagine in this age of realism that writers would try to be fairly accurate, or at least not make glaring mistakes. The latest literary production emanating from the fertile and imaginative brain of Mr. Hall Caine is a startling example of this slipshod tendency on the part of modern romancists. "The Christian" has raised a storm of criticism on all sides. Its accuracy as to details has been severely questioned, both from a lay and from a medical standpoint, and certainly the misstatements to be found in the work in respect to matters medical are extraordinary and amusing. The word pictures of hospital life and of a nurse's duties as portrayed in the description of Nurse Glory, while exhibiting the author's powers of imagination in a favorable light, also tend to show that his real knowledge of the subject is very little. To one who is acquainted from practical experience with the internal management of large hospitals, the accounts of the doings therein as set forth in "The Christian" will appear wonderfully funny. The entire book, indeed, is full of amusing perversions of medical knowledge, of which perhaps the most comical is Mr. Caine's definition of a stillborn child as one that has breathed but never cried.

The writer of fiction of the present day does not appear to advantage with many of the novelists of the past generation in his acquaintance and handling of medical subjects, although it must be confessed that even among the dead giants of romance there were but few whose description of a disease was absolutely correct. George Eliot is without doubt entitled to first place in this list; her sketches of doctors and her statements in regard to the diseases of which she treats are drawn with a masterly hand, and are as accurate as if written for a medical text book. Charles Kingsley, again, in "Two Years Ago," traces the history of a cholera epidemic with the utmost attention to technical minutiæ. Thackeray also described the course of a malady as correctly as he did the treatment pursued by the physicians of his time. Of modern novelists, Besant, in the "Ivory Gate," gives an interesting study of an obscure brain disease, and as he informs us in the preface that he procured his medical information from a competent doctor it may be taken for granted that his statements are correct. Putting on one side, however, the comparatively few instances in which the diseases dealt with by novelists are to be depended upon as being correctly described, the majority of the medical statements in fiction can be divided into two classes: those in which the accounts of diseases given are false in every respect; and those in which the author, not being au fait with his subject, is careful not to commit himself, and therefore wisely confines himself to vague generalities.

Another point worthy of notice is the small number of diseases brought into the service of the novelist. At one time brain fever was the universal favorite, with typhoid a good second, and although within recent years neurosis has to a certain extent banished brain fever from its proud position, yet the latter disease still holds its own in fiction. That nervous prostration is much more likely to attack the hero or heroine suffering from the storm and stress of life, as depicted in the ordinary modern novel, than is brain fever, cannot be denied. Nevertheless, there are occasions when an author, in order to extricate himself from a complicated situation, is compelled to fall back upon a disease of an acute nature; and in such a predicament, what so suitable as brain fever or what so convenient as its delirious ravings? The fact has been more than once pointed out that there is a disease which has been strangely overlooked, and which certainly deserves to find more favor in the eyes of the novelist than has hitherto been the case. This complaint is pneumonia, for, while it fulfills all the conditions required by the novelist, and to a fuller extent than brain fever, it has none of the disagreeable associations connected with typhoid. Pneumonia may be termed an aristocratic disease, while typhoid, though no respecter of persons, still has a certain plebeian flavor savoring of foul smelling drains and tainted water. In novels acute diseases invariably end suddenly. Pneumonia terminates by crisis; the onset of the attack is sudden, the temperature is always high; delirium, stupor or complete unconsciousness is a feature in its progress. Thus in this disease there is a choice of dramatic climax found in no other malady. A wicked man can be cut off in the midst of his sins, or a good one can be made to provide an edifying death bed scene. Pneumonia may be recommended to authors as a disease whose merits as an aid to fiction have not as yet received the appreciation from them which is undoubtedly its due. Consumption is a disease of such a nature that most novelists fight shy of it and are very chary of relating its tedious course. William D. Howells, in his latest work, has been bold enough to introduce a family all of whose members but one are afflicted with phthisis; and Gilbert Parker, in an interesting book he has lately written, has succeeded in rendering his consumptive hero a most fascinating and attractive personality. In connection with consumption in fiction, it is instructive under the present circumstances to note that Smollett, more than one hundred and fifty years ago, draws attention in "The Expedition of Humphry Clinker" to the prevailing opinion then existing that consumption was contagious. Heart disease is naturally a favorite with writers of romance when a character gets rather too obtrusive and it is deemed advisable to remove her or him from the scene. Marion Crawford, in a "Rose of Yesterday," has drawn a graphic picture of the life and death of a fast man; but the most powerful sketch of the stages of syphilis was that of Samuel Warren, entitled "Man about Town," included in his "Diary of a Late Physician." In present and past fiction too many examples have been afforded of the manner in which eminent writers can err when they enter upon descriptions of technical matters without taking the trouble to verify their statements. It cannot be expected of a novelist, however talented he may be, that he should be conversant with a disease by mere intuition, and if he trusts to his imagination and to some superficial observation, he will surely fall into grievous errors. When an author is distrustful of his medical knowledge, he should follow in the footsteps of the great masters of his craft, and either, like Dickens, touch upon such matters vaguely, or, better still, like Thackeray or George Eliot, obtain his information at first hand.

The Cleveland Iron Trade Review publishes detailed statistics of the lake shipments of Lake Superior iron ore during the shipping season of 1897, reaching a total of 12,215,645 gross tons, against 9,644,036 tons in 1896 and 10,233,910 tons in 1895, the shipments in 1895 being the largest made previous to 1897. The shipments in 1897 were distributed among the various shipping ports as follows: Escanaba, 2,302,121 tons; Marquette, 1,945,519 tons; Ashland, 2,067,637 tons; Two Harbors, 2,651,465 tons; Gladstone, 341,014 tons; Superior, 531,825 tons; Duluth, 2,376,064 tons—total, 12,215,645 tons. The shipments by ranges were as follows: Marquette Range, 2,540,575; Menominee Range, 1,911,152; Gogebic Range, 2,204,564; Vermilion Range, 1,278,481; Mesabi Range, 4,280,873—total, 12,215,645 tons. Of the total lake shipments in 1897 there were received at Lake Erie ports 10,120,906 tons, and 12,265 tons put into vessels at Two Harbors will remain at the head of the lakes through the winter. Taking the amount received at Lake Erie ports from the total as above, 12,215,645 tons, gives the total shipments to South Chicago and Bay View, and to the few charcoal furnaces that receive ore by water as 2,094,739 gross tons. Of this amount 1,897,018 tons went to the South Chicago, North Chicago and Bay View furnaces of the Illinois Steel Company and to the Iroquois Furnace Company's docks, leaving 197,721 tons that were shipped by water to charcoal furnaces in Wisconsin and Michigan. All rail shipments will bring the year's total shipments close to 12,500,000 tons.

ENGINEERING NOTES.

Coomassie is to be connected with the coast of Tacorady Bay by a railroad. Engineers and material have been sent out already from Liverpool. The line will run first to the Tarquah gold mines, a distance of forty miles, and then as soon as possible to the Ashanti capital.

It is well known that some makes of Swedish steel are not to be excelled, if even equaled, elsewhere. One of the best evidences of this superiority at the late Scandinavian Exhibition was a ribbon of steel, 8 inches wide, cold rolled, 2,354 feet long, and weighing 1,146 pounds, twined as a silken band would be round about the pavilion in which it was a notable exhibit.

The United Traction Company, of Pittsburg, reports the average life of its wheels to be 35,000 miles, and estimates that about one-third of this life is secured by prompt grinding of the wheels when flat spots are developed. The Consolidated Traction Company, of the same city, buys its wheels on a mileage basis, the manufacturers guaranteeing a life of 30,000 miles for each wheel, replacing those which have a shorter life and obtaining credit for those which have a longer life. Both companies use the Murphy wheel grinder.—Street Railway Journal.

The materials required to make a London and Northwestern locomotive have recently been added up, and the quantities of each work out as follows: Coals, 57½ tons; steel scrap, 28 tons; pig iron, 24 tons; Swedish iron, 6¼ tons; copper, 5 tons; coke, 4½ tons; spiegel, 2¾ tons; cast iron scrap, 1¼ tons; limestone, 18 cwt.; tin, 4¾ cwt.; manganese iron, 1 cwt.; red ore, 1 cwt.; lead, 83 lb.; zinc, 76 lb.; phosphor bronze, 70 lb.; chrome, 30 lb.; aluminum, 13 lb.; antimony, 4 lb. Although the component materials weigh in round figures about 140 tons, the finished locomotive only scales about 45 tons.

It is reported that Japanese engineers are preparing plans for the construction of a bridge across the Straits of Shimonoseki, so as to unite the main line of the Kin Sun Railway with that of the Sanyo Railway from Shimonoseki to Hiogo. The straits at the point referred to are about one mile in width, and the current through them is very rapid. The bridge, moreover, must be constructed sufficiently high to enable the largest ocean steamers to pass beneath. Thus the undertaking, if successfully carried out, would be one of the greatest engineering feats of its kind. The work will be undertaken and supervised by Japanese engineers exclusively.

Two powerful steam navvies have been recently shipped by the Toledo Machine Company, of Toledo, O., to the order of a railway company in Yokohama. These excavators weigh about 30 tons each and have an individual capacity of 1,500 cubic yards a day. The cylinders are 8 by 10 and the hoisting derrick is run by belt friction power. A new device for swinging the crane is so arranged that it fills the dipper, swings and dumps out and returns for another dipperful five times a minute. The cranes are of steel, and each has a forcing engine to force the dipper into the bank of soil. The boiler is horizontal, and 60 horse power. It is believed that these are the first steam navvies sent from the United States to a foreign country.

A new miner's prospecting machine specially applicable to the Klondike regions has been invented by Mr. William Schwarnwebber, of St. Louis, says Industries and Iron. At present it is necessary to build fires on the frozen gravel of the rivers in order to remove even a few inches of dirt. Six inches deep is considered a good thaw, and fire after fire has to be kindled to make an impression on the ground. The new machine consists of a steel screw which is bored into the frozen ground like a post hole auger. A cylinder of the same diameter as the screw and two feet in depth follows the screw into the ground. Within the cylinder is a bucket, which has an open bottom, into which the detached dirt and gravel are forced and packed. This bucket, when full, is elevated by a windlass attachment without losing any of its load. It can be emptied and returned to the well as often as required.

The New York Sun publishes an article on the expense of the navy which shows that the total displacement of the navy has advanced from 47,671 tons in 1890 to 136,839 tons in 1897; that the number of officers required to man the ships has advanced in the same period from 507 to 822, and the number of men from 5,131 to 9,231. The pay of the crews in 1890 was $2,464,394, and in 1897 it had advanced to $4,207,553. The total cost of maintaining the whole navy in the seven years jumped from $3,946,628 to $7,088,475. The experts hold that these figures show that the fighting strength has been more than trebled, the tonnage is nearly four times as great, and the cost of keeping the service in commission has advanced only a little more than one-third. The same figures show that it costs as much now to maintain the cruiser "New York" or "Olympia" in commission as it did seven years ago to run the whole South Atlantic fleet, and sometimes the Asiatic.

Summing up the work of the English dockyards, Engineering says: "There have been 45 warships constructed in 1897 for British and foreign powers, and these in fighting trim represent a value of £6,617,700, while in the previous year the total value was £10,750,000. This decrease is largely due to only one battleship being floated, whereas in last year's total there were included six of great size, four for Britain and two for Japan. Thus the tonnage in 1897 was only 96,786, against 155,849 tons in 1896; and even the latter was not a record, as the total in 1892 was 161,596 tons, although the average for the first six years of the decade is not over 100,000. The collective horse power of propelling machinery for all warships, however, does not show the same falling off, aggregating 331,050 indicated horse power, against 377,981 indicated horse power, due to the inclusion of a large number of torpedo boat destroyers. As in the past year, one-third of the tonnage completed was for foreign governments, principally Spain, Japan, China and the South American republics. There are in process of construction, including all vessels ordered and not yet tried, warships aggregating 355,620 tons and 766,800 indicated horse power."

MISCELLANEOUS NOTES.

The production of copper sulphate (known also as blue vitriol or blue stone) in the United States in 1897 was 49,000,000 pounds, against 48,732,840 pounds in 1896. The percentage of copper in this material is about 25. The greater part of the production of copper sulphate is made by chemical works in the East, but a good deal is turned out as a by-product by various gold and silver refiners.—Engineering and Mining Journal.

Large numbers of Chinamen have recently arrived in Berlin on their way to Stettin, where they are to become farm laborers. They came by way of Russia, because their journey through the United States is prohibited by law. They will be employed by cultivators of sugar beets. Farm labor is scarce in the district of Stettin, and for that reason the area under cultivation this year has been greatly reduced. Should the importation prove successful, there is likely to be quite an immigration of Chinamen into Germany.

Window glass and chimney manufacturers are still experimenting in Allegheny with a device for blowing window glass and lamp chimneys. The progress made has been very encouraging and the experimenters have decided to erect a large tank and keep on developing the new process. The tank will likely be built at New Kensington. Recently at the Allegheny tank a perfect cylinder 9 inches in diameter and 37 inches long was made. From the time the blowing of the cylinder was commenced until it was cut up into lights just 46 minutes were consumed.

The annual dividend list of the Fall River textile mills, just issued, is calculated to furnish additional support to the contention of the manufacturers that their business must be conducted at a lower cost. The report shows that eleven mills have passed dividends last year, as against three which did not pay dividends in 1896. The earnings of the mills as represented by the amount paid out in dividends were $776,300, against $1,368,875 in 1896 and $1,742,625 in 1895. This is an average on the total capital invested of a little over 3·38 per cent., against 5·95 per cent. in 1896 and 8·18 per cent. in 1895.

The masculine silk cocoon yields more silk than the feminine; hence for raising purposes such varieties as give more masculine eggs are by far preferable. Up to the present it was not easy to distinguish the masculine from the feminine cocoons; the distinction was solely founded on the greater weight peculiar to the feminine cocoon. The X rays have greatly facilitated the distinction. On account of containing the unripe eggs, rich in mineral salt, the hind part of the feminine cocoon is found to be by far less transparent than that of the masculine one. The dark shade in the vicinity of the ovary admits of readily recognizing the feminine silk chrysalis.

A curious industry has sprung up in Spain since the decline of silk culture there in the production of what is known as silkworm gut for fishing lines. The grub is fed on mulberry leaves, as usual in silk culture; but before it begins to spin—that is, in May and June—it is killed by immersion in vinegar. The substance which would have formed the cocoon is then drawn out from its body in the form of a thick silken thread, which is treated with chemicals and afterward dried. These threads are made up in bundles of 100, and the Spanish peasants travel with them along the shores of the Mediterranean as far as France. The best quality of thread is round, the flat form being inferior and due to the unhealthiness of the worm. The chief seat of this industry is Murcia.

A special blue printing arrangement for the rapid and convenient washing and drying of prints is used in the offices of Messrs. Milliken Bros., engineers and contractors, New York. Several large printing frames are set on trucks in the blue print room, and as soon as the prints are removed from them they are spread face up on wide slabs, slightly inclined from the vertical. Across the upper side of these slabs runs a perforated water pipe, says The Engineering Record. When the valve is opened this pipe throws a series of fine jets over the surface of the slab, forming a continuous sheet of water that flows down over the whole surface of the blue print, washing it off with clean water which is caught in a trough at the bottom and discharged into a waste pipe. When the prints are sufficiently washed they are hung on wires in a drying closet supplied with hot air from a series of Bunsen burners. These are located in asbestos lined compartments, separated from the drying chambers by wire gauze partitions, so as to allow free passage of air and prevent any danger of setting the paper on fire. This apparatus is exceedingly compact, has the advantage of requiring a minimum of floor space, and occupies for both washing and drying no more room than ordinary wardrobe cabinets. As a print may be washed and dried in two or three minutes, the two slabs and closets have a capacity of a large number of prints daily.

A publication issued by the French minister of finance gives some very elaborate statistics as to the quantity of wine, beer, cider and alcohol consumed in that country. From that document it is learned that the total amount consumed was 1,575,000,000 gallons, representing about 1 4-5 liters per diem for the whole population of France. The division was 967,000,000 gallons of wine, 395,000,000 gallons of cider, 202,500,000 gallons of beer and 36,800,000 gallons of alcohol. While the greater quantity of the wine is consumed in the large towns, the cider is nearly all drunk in the country, especially in Normandy and Brittany, and the official statistics give a table showing what is the consumption of wine in the forty-seven towns with over 30,000 inhabitants. The figures vary very much, the annual consumption being largest at Boulogne-sur-Seine, 59 gallons; Nice, 56 gallons; and St. Etienne, 54 gallons; while Paris is only thirteenth on the list, with 45 gallons. In none of the large towns in the south of France does the consumption fall below 30 gallons, but in seven large towns in the north (Lille, Boulogne-sur-Mer, Dunkirk, Caen, Calais, Roubaix and Turcoing) it averages only 6 gallons. Another table gives the consumption of alcohol, and here Rouen, Cherbourg and Le Havre head the list, with an annual total of nearly 4 gallons per head of the population, or more than double the quantity consumed in Paris.

SELECTED FORMULÆ.

Chewing Gum.—The manufacture of chewing gum is by no means the simple operation that it seems upon examination of the formula. Considerable experience in manipulation is necessary to success, and the published formulas can at best serve as a guide rather than as something to be absolutely and blindly followed. Thus, if the mass is either too hard or soft, change the proportions until it is right. Often you will find that different purchases of the same article will vary in their characteristics when worked up. Some manufacturers add a little paraffin or wax, to harden the mass, but the most successful attribute their success to the employment of the most approved machinery and greatest attention to details. The working formulas and the processes of these manufacturers are guarded as trade secrets, and, aside from publishing the following general formulas, we can give little information.

TOLU CHEWING GUM.

Chicle	3½ pounds.
Paraffin wax	1 "
Tolu balsam	2 ounces.
Peru balsam	1 "

Dissolve the gum in as much water as it will take up, melt the paraffin, and mix all together. Now take—

Sugar, finely granulated	10 pounds.
Glucose	4 "
Water	5 pints.

Put the sugar and glucose into the water, dissolve and boil them up to "crack" degree (confectioners' term), pour the sirup over the oil slab, and turn into it sufficient of the above gum mixture to make it tough and plastic, adding any of the following flavors if desired: Cinnamon, chocolate, sandal wood, myrrh, galangal, ginger or cardamom.

A somewhat different and more simple formula, taken from The New Idea, is as follows:

Tolu balsam	4 ounces.
Benzoin	1 "
White wax	1 "
Paraffin	1 "
Sugar, powdered	1 "

Melt together, mix well, and roll into sticks.

SPRUCE CHEWING GUM.

Spruce gum	20 parts.
Chicle	20 "
Sugar, powdered	60 "

Melt the gum separately, mix while hot, and immediately add the sugar, a small portion at a time, kneading it thoroughly on a hot slab. When completely incorporated, remove to a cold slab, previously dusted with powdered sugar, roll out at once into sheets and cut into sticks. Any desired flavor or color may be added to or incorporated with the sugar.—Pharmaceutical Era.

Determination of Tin in Small Quantities.—The estimation of tin in tinplate is often attended with considerable difficulty. A German contemporary recommends the following method: 25 grammes of the material are boiled for five minutes with 50 c. c. of 10 per cent. hydrochloric acid, and the liquid poured off into a 250 c. c. flask; the operation being repeated with fresh acid two to four times, until the iron is completely stripped. The solution does not need filtering, but is at once made up to the mark, and 50 c. c. treated with ammonia in a 100 c. c. flask till stannous hydrate begins to fall, when 10 c. c. of yellow ammonium sulphide are added, the whole shaken, filled up and filtered. Fifty c. c. of the filtrate are diluted with water, all the tin sulphide thrown down by acetic acid, and, after standing over night, the precipitate is brought on to a filter by the aid of 10 per cent. ammonium acetate. As, owing to the certain absence of copper, ammonium instead of potassium sulphide is employed, the washing need only be very slight; in fact, 50 c. c. of the sulphide solution can be directly evaporated and ignited in a porcelain crucible, but the former method is preferable. The precipitate is finally heated with fragments of ammonium carbonate until the ash is white.

Powder for Hardening and Restoring Freshness to Meats.—When the tissues of meats once break down there is no way, yet discovered, by which freshness can be restored to them. We can prevent further decay, remove odor, etc., but further than this we cannot go. The following formulæ all make more or less excellent meat preservatives:

1.

Borax	80 parts.
Boric acid	17 "
Sodium chloride	3 "

Reduce the ingredients to a powder and mix thoroughly.

2.

Sodium sulphite, powdered	80 parts.
Sodium sulphate, powdered	20 "

Mix.

3.

Sodium chloride	80 parts.
Borax	8 "
Potassium nitrate	12 "

Reduce to a powder and mix.—National Druggist.

Paste Blacking.—For paste blacking a great many formulæ have been published in these columns, but not very recently. The following seems to be as good as any:

Rancid butter	1 part.
Rapeseed oil	1 "
Mucilage of gum arabic	2 "
Fuller's earth	2 "
Molasses	12 "
Commercial sulphuric acid	2 "
Bone black	8 "
Prussian blue, q. s. or about	⅛ part.

Mix the acid and bone black and let stand overnight, then mix the other ingredients secundum artem.

We would remind you that commercial bone black consists largely of lime phosphate and other salts, the residue of the bony structure, and that until these are got rid of, a first-class black is an impossibility. The purified black can be obtained in the market, and only about one-third of the amount is required to produce a glossy black.

AN IMPROVED SUNSHINE RECORDER.*

By D. T. MARING, Instrument Division, United States Weather Bureau.

THE radiant energy of the sun produces several different effects at the surface of the earth, viz., light, heat and chemical changes. To obtain records of these effects from hour to hour and day to day, as is done of other atmospheric phenomena, and thus obtain the total work done by sunshine, has been a most difficult proble n for meteorologists, and one that has not yet been successfully solved. Automatic instruments have been devised for securing approximate records of the intensity and duration of each of these effects separately, but nothing has yet been perfected that will accurately indicate simultaneously the varying intensity of two effects such as the heat and light received from the sun.

Probably the first automatic sunshine recorder ever invented was that described in 1838 by Mr. Thomas B. Jordan, a mathematical and philosophical instrument

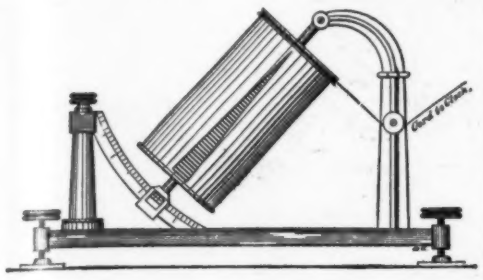


FIG. A.—T. B. JORDAN'S SUNSHINE RECORDER (HELIOGRAPH), PATTERN OF 1840.

maker, and secretary to the Royal Cornwall Polytechnic Society, Falmouth, England.† This was developed in connection with Mr. Jordan's efforts to produce a uniform and automatic system of self-registration for the various meteorological instruments then in use in that country, especially the mercurial barometer. For a record chart he used a paper covered with chloride of silver, which had about that time (1838) been discovered to be sensitive to the action of light, and to take different tints in proportion to the intensity of the light to which it was exposed, provided the times of duration of the exposures were equal. This paper was mounted on an inclosed vertical cylinder moved by clockwork and was placed directly behind the top of the mercurial column of the barometer, so that the surface of the paper would be exposed more or less to the action of diffused sunlight through the glass tube, depending upon the variations in barometric pressure. The vertical time lines were printed on the sheet and, by means of opaque lines for inches, etc., graduated on the glass tube, the barometer scale, the fluctuations in barometric pressure, and the time and comparative intensity of sunlight were all automatically and indelibly recorded on the sensitized paper by the action of the light itself.

This apparatus certainly embodied some very ingenious ideas, and appears to have constituted not only one of the earliest forms of self-recording barometers, but contained also the first automatic register of sunshine. As Mr. Jordan makes no mention of the use of artificial light, it is presumed records from this barometer sunshine apparatus were secured only during the hours of daylight, and his sample records, as engraved and reproduced in the report referred to,‡ are blank at night time.

Mr. Jordan's next attempt was to produce an independent instrument for sunshine alone, which he proposed to call "the heliograph," a name more correctly applied subsequently to a very different form of ap-

FIG. 1.—PHOTOGRAPHIC SUNSHINE RECORDER —WEATHER BUREAU PATTERN OF 1888.

paratus. With this "heliograph" he expected to obtain "an accurate account of the intensity of the light for every minute of the day, and to permanently register its indications."

An improved design of the above was brought out by Mr. Jordan in 1840,§ which he describes as follows, under the title of "Description of a new arrangement of the Heliograph, for registering the intensity of Solar Light:"

"The instrument for this purpose, described in pages 185 and 186 of the last Annual Report of the Society, is obviously defective, inasmuch as it calls on the observer's judgment to decide the intensity of the light, by a comparison of the different tints given by it to the prepared paper, and does not therefore admit of any definite mode of expressing the results of each instrument, so that those at distant stations may be compared with each other; and in consequence of the changes which the different tints undergo in fixing (and subsequently to that process), however carefully conducted, it is not possible to make any useful comparison of results obtained by the same instrument at distant times. The object of the present arrangement is to avoid these difficulties, by reducing the indications of the instrument to a scale, so that the light of each day, or each hour, may be distinctly registered by it in a way that will not admit of any difference of opinion as to the reading, and which may be at once expressed by a number and tabulated with other meteorological observations. This, of course, does away with all occasion for fixing the sheets with the results on them, as they may be destroyed as soon as these results are known.

"The accompanying sketch (Fig. A)* is an elevation of the instrument. It consists of two copper cylinders supported in a metal frame. The interior one is fixed to the axis, and does not revolve, being merely the support of the prepared paper. The exterior cylinder is made to revolve about this one once in twenty-four hours by a clock movement. It has a triangular aperture cut down its whole length, as shown in the figure, and it carries the scale of the instrument, which is made to spring closely against the prepared paper. This scale, or screen, is composed of a sheet of metal foil between two sheets of varnished paper, and is divided into one hundred parts longitudinally, every other part being cut out, so as to admit the light to the prepared paper without any transparent medium intervening. The length of the extreme divisions measuring round the cylinder are proportioned to each other, as one to one hundred, consequently the lower division will be one hundred times longer passing over its own length than the upper one over its own length, and the lines of the prepared paper under these divisions will, of course, be exposed to the light for times bearing the same proportion to each other.

"Now, as the sensitiveness of the paper can readily be adjusted so that the most intense light will only just tint it through the upper division during its passage under the opening, and the most feeble light will produce a similar tint through the lower division during its passage, the number of lines marked on the paper at any given time will furnish a comparative measure of the intensity of solar light at that time, and may be registered as so many degrees of the heliograph just as we now register the degrees of the thermometer. If it were considered desirable to compare the results of different instruments, of course it would be requisite that the scales should be exactly similar and the paper of precisely uniform quality."

Other modifications of this instrument were also made by Mr. T. B. Jordan, but, owing to the undeveloped state of photography sixty years ago, the records he obtained were not considered very satisfactory, and the instruments were found to be too expensive and unreliable for general use. At that early date there were, of course, no great national meteorological services in existence to take up and develop apparatus of this kind. It appears, therefore, that Mr. T. B. Jordan was the pioneer inventor in this field, and that his "photographic" sunshine recorders of 1838 and 1840 were the first of the kind used anywhere in the world prior to 1854.

Among the various forms of the so-called "sunshine recorders" that have been devised for measuring the time and duration of bright sunshine, one of the most important is that known as the "burning" recorder, invented by Messrs. Campbell & Stokes, of England, in 1854, and the improved form of the same designed in 1890 by Messrs. Whipple & Casella. These instruments have been used more or less extensively by foreign meteorological services since 1854, and operate on the same principle, that is, by concentrating the sun's rays through a glass sphere, acting as a powerful lens, upon a suitably ruled cardboard form, curved and held in focus at all hours of the day. But the degree of burning or charring of the line across this form or chart, for each day's record, gives only a very crude approximation to the thermal intensity of the sun's rays. The original "Burning" recorder, first designed by Mr. Campbell in 1854, used a glass ball filled with water as the lens; this was set within a round, shallow mahogany bowl, having a radius such that the surface of the wood was constantly in the focus of the lens. This apparatus being placed where it could receive the sun's rays at all hours of the day, the wood was burned or charred into a series of irregular grooves around the inner sides, and the bowls were of such size and shape that each contained a six months' record.

Thus was obtained a very crude record of the duration and intensity of the heat effect of sunshine for semiannual periods, but this must have been so imperfect as to constitute but the roughest seasonal approximation. The water globe was soon found impractical and was replaced by a suitable solid glass sphere, but the wooden bowls were apparently continued in use for several years before being generally replaced by the more convenient cardboard forms invented by Whipple & Casella.

The photographic sunshine recorder now used by the British meteorological service is that designed by Mr. James B. Jordan, in 1885. This makes a record of the time of duration of sunshine (actinic effects) on sensitized, blue print paper. The same principle has been used for several years in the Weather Bureau photographic sunshine recorder, which is a constructional modification of Jordan's invention, and is shown in Fig. 1. In the Weather Bureau instrument, as designed by Prof. C. F. Marvin, in 1888, the sensitized sheets need be changed only once or twice a month, and a simple expedient is resorted to, in ruling the record sheets, to eliminate the effects of the progressive variations in the meridional altitude of the sun.

In 1891 the present writer suggested a form of differential thermometer as a sunshine recorder, illustrated in Fig. 2, by means of which the presence of effective sunshine could be automatically and electrically recorded at a distance on the standard registers of the Weather Bureau, simultaneously with other data. This "thermometric recorder" has been extensively introduced at the regular stations of the bureau in the United States, and, in connection with the photographic recorder shown in Fig. 1, is fully described in the pamphlet, W. B. No. 109, entitled "Care and Management of Sunshine Recorders." It is probable, however, that as in all other kinds of sunshine recorders, so now, the records obtained from this instrument at the various stations are not strictly comparable with each other, nor with those obtained from the photographic sunshine recorders, owing in part to the various different adjustments of the mercurial column

FIG. 2.—THERMOMETRIC SUNSHINE RECORDER (PATTERN OF 1895) MOUNTED.

that are unavoidable in an instrument operating upon this differential thermometer principle.

From careful comparative tests made in England, Mr. James B. Jordan decided that, although his improved photographic instrument (using blue print paper) registered, on an average, about 11 per cent. more sunshine than the "burning" recorder, yet there is no real antagonism in the records (each being valuable); for, while the former registers the delicate actinic effect, the latter gives only the grosser heat effect for a certain greater degree of intensity ordinarily known as "bright sunshine."

To record and tabulate simply the duration, in hours and minutes, of bright sunshine, as obtained by the above mentioned sunshine recorders, and as is now generally done by the various meteorological services throughout the world, does not give all the information desired relative to the sun's rays, nor all that is really required for a satisfactory study of this important element in meteorology. What seems to be really needed is a simple form of apparatus which will automatically and simultaneously record each of the various effects of radiant energy in such a way that the real varying intensities of all parts of the solar spectrum will be obtained in a satisfactory and comparable manner.

The writer has been experimenting for several years past, and, after numerous plans and suggestions had

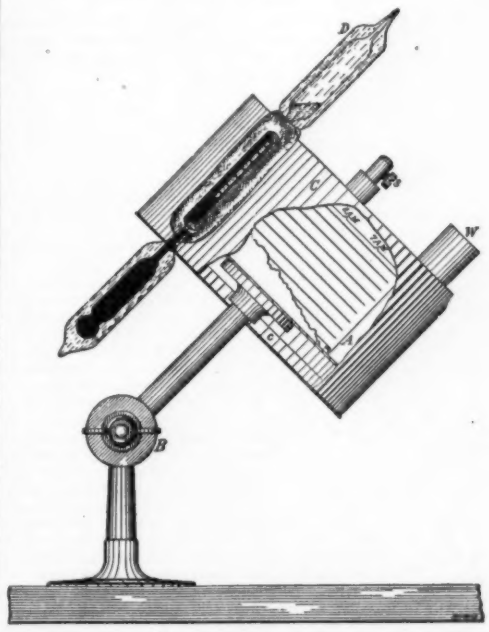


FIG. 3.—NEW PHOTO-THERMO RECORDER—(MARING'S ORIGINAL WORKING MODEL OF 1897).

been tried, an instrument was finally devised which now gives promise of fruitful results. This is a combination of the principles contained in the two Weather Bureau instruments, the photographic and thermometric sunshine recorders respectively, whereby the height of the column of mercury in the latter instru-

*Reprinted from The Monthly Weather Review of the United States Department of Agriculture.

†See the Sixth Annual Report of the Royal Cornwall Polytechnic Society, 1838, p. 184.

‡Ibid.; Plate VII.

§Seventh Annual Report, Royal Cornwall Polytechnic Society, 1839, p. 115.

*Seventh Annual Report, Royal Cornwall Polytechnic Society, 1839, Plate III. Fig. 3.

ment is automatically recorded on a strip of photographic (blue print) paper.

The original working model is shown in Fig. 3, part of the outer cylinder being cut away to illustrate the method of operation. A is a circular brass case inclosing a strong eight day clock movement and rigidly mounted on the adjustable metal support, B. The clock turns the outer cylinder, C (which is also of brass), once in twenty-four hours, and keeps the differential bright and black bulb thermometer of glass, D, constantly exposed directly toward the sun. The cap, c, closes the lower end of the cylinder, C, perfectly tight, and is held in place by friction. The cylinder itself is secured to the clock pinion by the set screw, s, and is removed entirely when a new sensitized sheet is to be put in place. Directly behind the central stem of the differential thermometer a narrow slot is cut through the cylinder, C, so that it will be completely covered by the mercurial column as it rises with the increasing intensity of sunshine. The strip of sensitized photographic paper is wrapped around the circumference of the part, A, and is held in place by suitable clips.

This apparatus is placed in a position where it will receive the sun's rays at all hours of the day and at all seasons of the year, the cylinder, C, being parallel with the axis of the earth. Ordinary blue print paper is used, and is attached to the case, A, with the upper edge of the sheet under a fixed projecting piece of thin brass having the hours perforated therein and indicated by notches or holes at accurate distances apart. It will be seen that, as the cylinder, C, revolves with the sun, the instrument will automatically record its own time marks on each sheet. Furthermore, by stretching fine wires across the slot behind the mercurial column, the horizontal record lines for the scale of varying intensities of sunshine will be photographed in white. The differential bright and black bulb thermometer, D, is made similar to the present Weather Bureau thermometric sunshine recorder (Fig. 2), except that each bulb is in an independent vacuum. The glass tube is attached rigidly to the cylinder, C, and cemented in place so that the cylinder is watertight. The weight of this glass part is counterbalanced by the weight, W, so as to insure a regular rate for the clock.

This photo-thermo recorder is, of course, capable of being much improved as regards mechanical construction. Without adding much to its size or cost, it can readily be made to produce an entire week's record, which is very desirable. The inexpensive American clocks are strong and sufficiently reliable timekeepers for the out-of-door conditions to which an apparatus of this kind must necessarily be exposed. Still, if the clock is unsatisfactory, the cylinder could be revolved by suitable mechanisms operated by electricity. The differential thermometer could also be made electrically recording, as at present, without interfering with the photographic record of intensity. One of the advantages of a photographic recorder operating on this principle is that the sensitized paper is securely inclosed and protected in a watertight case, and the records cannot be affected by rain and dampness, as in the present forms of these recorders. A more delicate and sensitive paper can therefore be safely used. Another advantage is that it uses the plain, blue print paper, which can now be procured almost everywhere of dealers in photographic supplies, which paper is generally of far greater excellence than any that can be made in small quantities by hand.

Information relative to the intensity of solar radiation has been urgently needed for many years in the study of sanitary climatology and in investigations as to growth of crops and agricultural interests generally, and it is hoped this article may lead either to the perfection of present forms of sunshine recorders or to the invention of something new that will furnish this important factor in our meteorological problems.

MODERN VIEWS OF THE RAINBOW.*

DESCARTES' theory of the rainbow, which is still found in all optical textbooks, is hardly even a rough approximation to the true theory. It does not fully explain the ordinary bows, and fails entirely as regards the "spurious bows," improperly so called. Any close observer will, under favorable conditions, notice certain colors on the inside edge of the primary bow which are not consistent with the simple series of spectrum colors demanded by the venerable theory which may be said to mark the birth of modern science. These additional colors, chiefly red and green, recall the colors seen in Newton's rings at some distance from the center, and at once suggest a similar origin. In a paper on "The intensity of light in the neighborhood of a caustic" (Trans. Camb. Phil. Soc., 6, 1838, and 8, 1848), Airy has laid the foundation of an adequate theory of the rainbow which is gradually being worked out. With a considerable amount of patience, Mr. J. M. Pernter has calculated the tints and the angular deviations of the rainbow colors for various sizes of raindrops, and has devised experiments in support of his deductions. A parallel beam of sunlight after reflection and refraction in a spherical raindrop does not emerge as a parallel beam, or as a bunch of parallel beams of various colors, but as a series of caustics of somewhat complicated nature, in which the divergence of the colors, and hence their distinctness, separation or coincidence, depend upon the ratio of the radius of the drop to the wave length of the light. The influence of size is very formidable in the smaller drops, say of 0·01 mm. radius. This would be a very fine spray. The actual size of raindrops is supposed to vary between 0·1 mm. and 2·6 mm., but the heavy drops of tropical rains are said to attain diameters of 3·4 mm. Their size may be estimated by catching and weighing a definite number, or by the more difficult method of diffraction. The tables drawn up by Pernter consider drops of twelve different sizes between 0·005 and 1 mm. radius. In order to determine the resulting colors, Pernter selects eight of Maxwell's twenty-two color equations, which number he finds sufficiently accurate. The first set of his tables state, for a point source of light, the sequence of colors, their composition in terms of red, green and violet, the relative intensity (admixture of white, after Abney) and position on the color triangle of each shade for various deviations between 42° 20′ and 36°. These tables are then verified by experiments with cylindrical streams of drops according to Babinet's method. With 1 mm. drops, Pernter observed red, orange-yellow, green, violet, blue, second violet, and then twenty-four secondaries or spurious colors, chiefly pinkish-violet and green or blue; after the twelfth violet came a whitish band, and then a reversal in the sequence of the colors. The 0·5 mm. drops gave 11 bows with 40 shades. The outer bow and its secondaries were also observed. Verifications in nature are hardly possible, as we cannot measure simultaneously the angles and the size of the drops producing the bow; it is striking, however, that so very few angular measures are extant

The white or pale rainbows (fog or mist bows) around moon and sun may appear pale owing to (1) the feeble intensity of the light, (2) the uneven size of the drops, and (3) the mixture of colors. The first cause is probably a real one; the second Pernter is inclined to reject, since the accompanying, often well-defined features such as "glories," Brocken spectra, etc., and also his own tests require homogeneous conditions. As regards the third, Abney has proved that all colors of any shade disappear on being diluted with 75 parts of white, and Pernter's tables show that such cases may well occur. Further, Airy's theory renders white bands possible for all sizes of drops, and necessary for radii below 25 μ. As a stream of water of such fineness cannot be maintained, Pernter produced a mist spray by fixing a 0·5 mm. glass tube in a lead pipe connected with the Innsbruck water mains (pressure 5 atmospheres), and directing the jet against a metallic plate; the size of drops was derived from measurements of diffraction rings. Drops of radius 5 μ gave a yellow margin at 41° 59′, white between 41° 8′ and 38° 27′, and then blue to 37° 41′; larger drops were more difficult to manage. From measurements of fog bows on Ben Nevis, J. McConnell had in 1890 already calculated the sizes of the respective drops. But some of these observations speak of a red outer margin, for which Pernter looked in vain, and which his calculations do not indicate; Crailheim-Gyllenskiöld (Swedish North Pole expedition, 1882) also describes the margin as of ocher color. The classical white bow of Bouguer (1744) and of Scoresby (1821), however, do not fit into the theory at all, and were probably due, as the observers remarked, to ice needles.

The general conclusions are interesting to meteorologists. The greater the drops, the more secondaries (spurious bows). A chief bow of intense pink and green (hardy any blue) indicates drops of diameters ranging from 1 to 2 mm.; intense red always speaks for big drops. Secondaries of green and violet (the blue is masked by contrast) without yellow, immediately joining the chief bow, correspond to drops of 0·5 mm., while five and more secondaries without white and without breaks mark drops of 0·1 mm. A partly white bow is produced by drops of 0·06 mm., and when the drops are still smaller, a real white bow with orange-yellow and blue margins is the result. The net result of these elaborate investigations will be to add a new interest to a natural phenomenon already endowed with many associations of magic and beauty.—*Nature*.

*See a paper by J. M. Pernter, Wien. Ber., 106, part 2, a, 1897, and Abstracts of the Physical Society, No. 36.

EFFECT OF THE "BORA" IN DUGA PASS, MONTENEGRO.

FROM A DRAWING FROM NATURE BY PROF. FRANZ SVERINA.

THE EFFECT OF THE "BORA" IN THE DUGA PASS, MONTENEGRO.

WE publish to-day a reproduction of a drawing by Prof. Franz Sverina, from which our readers can gain some idea of the terrible work done by the "bora," a violent and bitterly cold northeast or east wind that prevails along the eastern coast of the Adriatic Sea at certain seasons of the year. It is supposed to be caused by a disturbance of the warm air over the sea and the rush of the colder air from the land to take its place as it rises. The bora sometimes prevails for days, and, according to careful observations made in Trieste and Fiume, attains a velocity of fifty miles, or more, an hour, but its greatest danger lies in the suddenness with which it rises and the fitful manner in which it blows. There is no infallible sign of its approach. The sky will be clear and blue, there will be no bank of clouds on the horizon, the only indication that a storm

is brewing being a thin horizontal cloud about the tops of the highest mountains, which the inhabitants of that country call the "signal." The atmosphere at these times is most healthful and invigorating, and the natives find it much more bearable than the conditions which accompany the sirocco, when the air is damp, warm and depressing.

It is interesting to see how all forms of life in the region visited by the bora adapt themselves to the temper of their stormy guest. Trees and shrubs never grow very high, and their branches spread in a southerly or southwesterly direction, even the stems of plants incline that way, and men have, of course, learned to build their houses so that they will offer a safe shelter during the storms. The roofs, which are heavily loaded with stones, project only on the southern and southwestern sides, and the doors and windows open in the same directions. But, in spite of this, the wrath of the storm always demands some sacrifices of men and animals who are overtaken by it in such places as the Duga Pass, shown in our engraving (for which we are indebted to the Illustrirte Zeitung), in which we see animals that, while on the steepest and

BUST OF GALLIA BY LUCIEN FALIZE.

most dangerous part of the pass, perceived the approach of the bora, became more and more restless, pressed close together, and finally broke away and rushed down the steep path, seeking the safety offered by the valley; but the malicious bora surprised many on the dizzy heights, and woe to all who were unable to find shelter in nooks in the rock or to obtain a hold of any kind; they were swept off like chaff and hurled into the abyss. There is a never-ending struggle between the inhabitants of the Black Mountains and the overwhelming forces of nature, and yet these people are devotedly attached to their rugged home, which was the last refuge of the old Servian freedom that was swept away by the Ottomans, whose attacks were as devastating in one way as those of the bora are in another. In former times this pass often resounded with the clang of the weapons of Ottomans and the Montenegrins, and it is still an important military stronghold with many fortifications.

M. Camille Flammarion has undertaken to cinematograph the sky. He takes 3,000 photographs a night when it is clear and expects to show realistic pictures of the movements of moon and stars.

FALIZE'S BUST OF GALLIA.

FALIZE'S bust of Gallia is now in the gallery of sculpture of the Luxemburg Museum. Before the last arrangement of the pictures and statues, it was placed in the center of the first hall of paintings. Behind it were displayed the rich showcases of goldsmith's work and enamels; and in the opinion of its designer it here found a normal vicinage. In executing it after the original of M. Moreau-Vauthier, master goldsmith Lucien Falize had, in fact, but one pretension: "I have desired," said he, "to produce a piece of trade work which should prove that, as regards style, our skill is abreast of that of the best epochs of art."

The head of Gallia is carved from a piece of ivory and surmounted by a gold helmet enriched with emeralds and rubies. The chest is covered with a coat of mail of old silver held by straps of gold, and upon the shoulders are lions' faces having emerald eyes. A series of leather straps stamped with gold detach themselves from the helmet and fall around the neck. The decoration is strengthened by motifs of expression; the helmet in the form of a dolphin's head surmounted by a dragon, and a head of Medusa placed upon the breast in the center of the armor. Such as it is, this bust could, in fact, find terms of comparison only among similar works, the products of the goldsmith's art.

But since its present place in the gallery of sculpture constitutes a presentation of honor, it would be impossible to find fault with a homage that is addressed as much to the original bust by Moreau-Vauthier as it is to Falize's work of interpretation, and, through it, to our decorative art, of which goldsmith's work is one of the most legitimate representatives.

Among the many productions of Falize, amateurs hold principally in esteem "Urania's Clock," in gold, ivory and enamel; the "Angelus Clock," in ivory and gold, in the style of the twelfth century; the "Sassanida Vase," in rock crystal, gold and enamel; the "Ship of Peter the Great," belonging to Grand Duke Vladimir; the "Billow," an epergne in massive silver; the "Crown," which the Czar deposited upon Carnot's tomb; the "Hammer and the Trowel" of the Alexander III bridge; the "Mortuary Crown" of Duc d'Aumale; the four panels of Prince de Bearn (Gaston de Bearn, Gaston de Foix, Anne de Bretagne and Marguerite de Navarre); the "Olive Crown," of fine gold, which President Felix Faure deposited upon the tomb of Alexander III; and the "Three Coronations," one of Falize's most valuable works, for which the museums of Kensington and Berlin are now disputing.

The "Goblet of the Decorative Arts" worthily terminates both this series of pieces and a career which signalized itself by the restoration of mosaic work in enamels and of bass-relief enamels to a place of honor, and by the creation, in practical order, of a syndical chamber of goldsmith's work.

If Falize had not been taken away from us so prematurely a few months ago, some new projects, bolder still than the "Goblet," would have seen the light for the Exposition of 1900, and have affirmed anew the artistic law formulated in the report upon the class of goldsmith's work at the Exposition of 1889. The rosette of officer of the Legion of Honor that Falize received on this occasion had been valiantly won; and although the master goldsmith did not realize all his ideas, he produced enough to save his name from oblivion.—Le Magasin Pittoresque.

THE MAGNETIC PROPERTIES AND ELECTRICAL RESISTANCE OF IRON AT HIGH TEMPERATURES.*

THE magnetic properties of iron and, to a lesser extent, of the associated metals—nickel and cobalt—have always been a fascinating subject of study. Possessed by these three metals alone, these properties, so peculiar and so different from any of the other known properties of mater, have imparted to the study of these so-called magnetic metals a special charm and interest, apart from that excited by the vast industrial importance of at least one of them.

Among the very early inquiries into the nature of magnetism there were not neglected experiments on the effect produced by change of temperature. Three centuries ago Gilbert recorded the observation that a piece of iron or steel, if heated more strongly than up to a full red heat, ceased to be attracted by a magnet, though it regained its previous magnetic qualities on cooling below that temperature.

Until comparatively recently, however, accurate magnetic measurements, even at ordinary temperatures, could alone be made on permanent magnets and the forces acting on their poles. The capability of acquiring temporary or induced magnetism when near a magnet, which is the characteristic property of soft iron, could not be subject to strict measurement until it was shown, first, how a given specimen of iron could be uniformly magnetized in a uniform magnetic field; and, secondly, how both the magnetizing force of that field and the consequent magnetization of the iron could be measured. We know of only one way of completely satisfying the first condition, namely, by covering a ring-formed specimen (whose outer diameter but slightly exceeds the inner) with a uniform layer of insulated wire carrying an electric current, thus forming a ring magnet with no disturbing poles. And Faraday's researches on electro-magnetic induction have furnished us with a method, at once accurate and convenient, of determining the magnetization of the apparently unmagnetized ring magnet, i. e., by the use of a "secondary winding" or outer layer of insulated wire connected with a "ballistic" galvanometer. Knowing, then, the intensity of magnetization called up by a given magnetizing force, we can, from their ratio, express the facility with which the iron takes up magnetic induction, or, in other words, its magnetic permeability.

To apply this method to the measurement of permeability at high temperatures, both the magnetizing and the secondary winding must be so insulated as to be uninjured by the heating; and, further, the thermometer or pyrometer, which measures the temperature, must be placed inside the ring, so as to measure the actual temperature of the iron.

Among the earlier important researches on magnetic properties at high temperatures, that of Baur, of Zürich, in 1879, should be mentioned. He experimented simply on an iron bar heated in a furnace, and thence rapidly transferred to the interior of a straight magnetizing coil. Not, however, till 1889 was it shown by Dr. Hopkinson, in his classical researches, that the ring-magnet method could be successfully applied to the measurement of permeability at high temperatures. The windings of the ring magnets were, in this case, of copper wire insulated with asbestos; the heating was carried out in a gas furnace, and the rise of temperature of the iron core was deduced from the increase of the electrical resistance of the secondary winding.

Of the more recent researches, the most remarkable is that of M. Curie, published in 1895, describing experiments on the magnetic behavior of a great variety of substances at temperatures ranging up to a white heat. The method he adopted—that of finding how strongly the specimens were attracted when placed near a powerful magnet—was well adapted to determine permeability in intense magnetic fields, but it is much inferior to the ring-magnet method, where the permeability varies much with the magnetizing force, as is the case whenever the magnetic field is not intense.

In the course of some experiments on the subject of this article, the results of which have been recently published, I have endeavored to approximate, where possible, more closely than previous experimenters to the ideal method which would be the outcome of the principles laid down above. The ring magnet, whose core was the iron specimen to be tested at high temperatures, was made very small, measuring about one inch across. The temperature of this core was determined by means of an electrical thermometer embedded in it, consisting of a wire of pure platinum whose electrical resistance at any temperature had been previously determined, and whose resistance, therefore, if subsequently measured, gave its temperature, and hence, also, that of the iron core in which it was laid. Asbestos paper insulation, as had been used by former experimenters, was found to be very imperfect at high temperatures, owing largely to carbon deposited from the materials used in its manufacture. This difficulty was, after some trouble, overcome; but wherever a high degree of insulation was wanted, as in the case of the thermometer wire and secondary winding, it was found necessary to employ mica, though, as may well be imagined, the use of such an untractable material for such

* David K. Morris, in Nature.

a purpose is beset with considerable mechanical difficulties.

Now, to find the magnetic condition of a sample of iron at a given temperature with any completeness, it is not sufficient merely to measure its permeability in various magnetic fields; the behavior of the iron when subjected to what is called a "cyclic" process of magnetization must be studied—the "hysteresis" or energy absorbed in one double reversal of the magnetization of each cubic centimeter of the iron must be measured.

But the taking of so many observations requires time; and if, during this time, the temperature of the iron be not perfectly constant, all efforts at refinement in the magnetic measurements are thrown away. The heating of the ring must, then, be thoroughly under control. The method I adopted was an electrical one. The ring magnet was furnished with an extra winding of asbestos-insulated platinum wire, so wound as to have no magnetizing influence; and by passing through this wire a suitable electric current, heat could be generated in the ring at any desired rate. This method, however (the principle of which was adopted as long ago as 1888 by M. Ledeboer), is not used to full advantage unless combined with an effort to thermally isolate the body to be heated. Each ring magnet was, therefore, thickly wrapped with asbestos and supported in the center of a closed and partially exhausted glass vessel (oxidation of the iron core was also in this way avoided).

This method of heating proved most satisfactory. The loss of heat by radiation and conduction being slight, the ring magnet could not rapidly alter its temperature; and there is probably no way in which we can supply heat energy to a body which can compete with the electrical resistance method, either as regards constancy or control. For obtaining temperatures up to 1,300° or 1,400° C.—a white heat—this method, combined as far as possible with "thermal isolation," and an electrical method of measuring the temperature, should in the future prove of the greatest value in all cases where the physical properties of bodies at high temperatures require careful investigation.

The original intention of my experiments was to ascertain exactly in what way the specific electrical resistance of iron changes at and about the "critical temperature" at which the magnetic properties of iron so nearly disappear, so as to throw light, if possible, on the molecular state which we characterize by the term "magnetic." With this object, the iron core of the ring magnet was formed of a long insulated iron strip, among the turns of which the platinum thermometer wire was buried; and with this piece of apparatus simultaneous measurements of the magnetic qualities and electrical resistance of a sample of iron could be made with accuracy alike at low and high temperatures.

Let us now consider the magnetic changes which occur in soft iron when heated. At ordinary temperatures iron shows a kind of unwillingness, so to speak, to become slightly magnetized—its permeability under small forces is not great. Beyond a certain limit, however, it exhibits the greatest readiness to become further magnetized, and continues to have a high permeability until magnetized very strongly. But from this point it begins to show signs of magnetic saturation, and ultimately refuses to be further magnetized without the application of very great force.

Now, as the temperature of the iron is gradually raised, it is found that practical magnetic saturation takes place sooner and sooner. Iron refuses to become so strongly magnetized at higher temperatures. Thus the permeability in strong magnetic fields falls off as the temperature rises, very slowly at first, then more rapidly, till, near the "critical temperature," the permeability rapidly drops to quite a low value.

On the other hand, in weak magnetic fields, the behavior of iron up to within a few degrees of the "critical temperature" is precisely opposite. The permeability rises with the temperature, at first slowly, then above 500° C. with ever increasing rapidity, until at last that lack of susceptibility to small forces disappears, and iron shows itself just as amenable to magnetic influence in small magnetic fields as in the larger ones, where the maximum permeability occurs.

At this temperature, say 15° below the critical temperature (about 750° C.—a red heat), iron possesses all those qualities at once which are sought after by the transformer maker—practical absence both of hysteresis and of eddy currents (the latter owing to the greatly increased electrical resistance), and a permeability nearly four times as great as that attainable in commercial transformer iron. So magnetic, indeed, is the iron that even the earth's magnetic field, in the direction of its greatest intensity, is enough to induce strong magnetization (B = 5,000), in fact, almost saturate the iron (for which, at this temperature, a relatively low induction suffices). The behavior of a compass needle near a slowly cooling ingot of cast steel should be rather interesting, for just below the critical temperature the vertical ingot must behave as a very powerful magnet indeed.

For all the lesser magnetic fields, there is a temperature of maximum permeability which is nearer to the critical temperature the smaller the magnetic field. But at that temperature the magnetic qualities in almost all fields practically vanish. Hence, when the magnetizing force is very small, the change from enormously magnetic to almost non-magnetic takes place with extreme suddenness.

Above the critical temperature iron is but feebly magnetic; yet it is still much more readily affected by a magnet than most other feebly magnetic bodies. Not till a white heat is reached do the magnetic qualities of iron become imperceptible.

It is not easy in an article like the present to deal with the changes which occur in the electrical resistance of iron, but the following remarks may be of interest:

The experiments of Dewar and Fleming have shown that at a temperature of —200° C. the specific electrical resistance of iron is extremely low. Throughout the range of temperature included between that extreme of cold and the critical temperature—about + 780° C.—the resistance rises at a steadily increasing rate, so that at the latter temperature it is over 150 times as great as at the former: far in excess of that of any known alloy at ordinary temperatures (crystalline metals and their alloys excepted), and about equaling liquid mercury for high specific resistance. On still further raising the temperature of the iron, it is found that the rate of rise of resistance, instead of further increasing very rapidly, falls off till, at a white heat, the resistance of iron increases only slowly with the temperature.

It has long been known that this increasing rate of rise of resistance with temperature is a characteristic possessed by the magnetic metals alone. Here now we see that no sooner does the iron cease to be strongly magnetic than this quality disappears and becomes exchanged for an opposite one, namely, a decreasing rate of rise of resistance with temperature. In some hitherto unpublished experiments on Hadfield's manganese steel (a non-magnetic steel which can be rendered magnetic by annealing), I have observed a precisely similar change of the resistance temperature function to take place during the annealing of this steel, thus furnishing a second case of this obscure resistance change accompanying the change from magnetic to non-magnetic in one and the same sample.

The connection between magnetic and electrical properties is evidently not a very simple one, but in the face of these facts it is hard to deny that there is one; and it is only by trying to find out how the various physical properties depend upon magnetism that we may hope to arrive at a comprehensive explanation of that obscure but most interesting condition of matter.

HIBERNATION.

THE phenomenon of hibernation in animals, fish, and reptiles is something that from its very nature and surroundings cannot be investigated, and consequently little is known as to its cause, or as to what physiological changes occur to animals that habitually retire to concealed places and lie dormant, or in a lethargic sleep, for days, weeks and even months. It is known that in the perfect hibernators the processes of nature are interrupted during the period of this long insensibility. Breathing is nearly and in some hibernators entirely suspended, and the temperature of the blood, even in the warmer blooded animals, falls so low that how life can be maintained by it is a mystery of mysteries.

A variety of Rocky Mountain ground squirrel, when in perfect hibernation, has a temperature only three degrees above the freezing point of water, and when taken from their burrows in that condition these squirrels are as rigid as if they were not only dead, but frozen. But a few minutes in a warm room will show that they are not only alive, but full of life. This interesting fact in natural history was first demonstrated by the late Andrew Fuller, of Ridgewood, N. J., to whom a friend in the West sent a pair of these squirrels. When the weather became cold, Mr. Fuller missed his pets one day. He supposed they had run away from his premises. Nearly a month later he found them by accident curled up beneath a pile of straw in one corner of an inclosure on his place. They were so cold and stiff that he supposed they were frozen to death. He carried them into the house to show his wife the fate that had befallen the poor little rodents in the harsh Eastern climate. While he and she were discussing the matter sorrowfully, the squirrels began to show signs of life; and shortly were frisking about the room as if they had not been apparently frozen stiff for weeks.

Mr. Fuller then knew that the squirrels had been in a state of hibernation, and it was such an extraordinary one that he put them out of doors again to let them resume that condition if they might, so he might investigate it further. They had no sooner got into the cold air than the lethargic state began to assert itself, and Mr. Fuller covered them with the straw. A month later he took their temperature and found it to be as I have stated—only three degrees above the freezing point of water. Again they came back to life and activity when placed in the warm room, but after a few hours showed plainly that they were being bereft of their natural winter sleep. Mr. Fuller turned them loose to find it again. They found it as before, and they remained in that condition until the warm weather returned in the spring, when they came out as chipper as if they hadn't lost a day or a meal.

As to the suspension of breathing in hibernators, the fact is proved sufficiently in the instances of the raccoon and the woodchuck. When they have laid themselves away for their winter sleep, they roll themselves up so comfortably and press their noses in such a peculiar position against their hinder parts that it would be an absolute impossibility for them to draw a breath. The popular backwoods belief is that the bear rolls itself up in this way and does not breathe, but, while the bear is classed as a perfect hibernator by naturalists, it breathes while in its lethargy, as its blow holes in the snow prove—holes melted in the snow beneath which the animal frequently stows itself away, under a covering of leaves, which holes frequently betray its presence to the woodsman.

The marmot family produces the soundest winter sleepers. When the marmot is in its peculiar state of hibernation the electric spark will not rouse it. The most noxious gases do not affect it in the slightest. If its temperature is raised above that at which the animal breathed in its natural state, it will die almost immediately. This is on the authority of the late Prof. Peter A. Browne, who at one time was connected with Lafayette College, and investigated the subject of hibernation and estivation further than any other scientist that I know of.

The hamster, a rodent common in northern Germany, is another animal that has its peculiarities as a hibernator. Prof. Browne mentions a hamster that was put into a box which was closed with earth and straw and placed where the cold was intense, but the hamster did not show any sign of becoming torpid. The box was then buried in the ground and was dug up after some hours, when the animal was found in a state of the most profound lethargy. And this hamster was kept in a room where there was no fire. The animal rolled itself up in a corner, but presently woke up and came out. It was in the best of health, but died in a few days—"suffocated," Prof. Browne declared, "because it could not have confined air."

Our own familiar wild animals, the bear, the raccoon, and the woodchuck—the groundhog of colloquial nomenclature—are classed as perfect hibernators because they store no food for winter, but have acquired a thick, fatty secretion between the skin and flesh, which, it is supposed, supplies them with sustenance. As a matter of fact, although dormant animals absorb fat, it does not enter into their digestive organs. The same fat absorption occurs when the animal is dead. If you kill a rabbit, or any other animal, and leave the entrails in it, the fat will disappear in a short time. Remove the entrails, and the fat will remain. Food introduced into the stomach of a hibernating animal or reptile will be found undigested at all stages of its lethargy. I say "introduced into the stomach," because it could get into the stomach of such a creature only by force or artificial means, for a hibernating animal invariably goes into its peculiar state on an empty stomach. Why? I do not know. That is one of the mysteries of the phenomenon. But the most mysterious of all things connected with hibernating animals is that, although bears and woodchucks are profound hibernators, they produce their young during their winter sleep.

The woodchuck is undoubtedly a perfect hibernator, and the female bear is, but the male bear is frequently roused from his winter sleep, and is found roaming about in midwinter. A bear hunt when the snow is deep and the cold intense is not an uncommon relief to the monotony of life in the backwoods, but the hunted bear is invariably a male. I have talked with scores of old and observant woodsmen, versed in the ways and haunts of wild beasts, but none has ever been able to say yet that he ever knew a female bear to be killed after the season for hibernation has come, and none has ever yet seen a gravid female bear. Where do the females go during that time, that they are never disturbed in their retreats? No one can say.

The raccoon is often gregarious in its hibernating, and it may be that for that reason it not infrequently comes forth from its snug quarters in the hollow tree and makes foraging trips about the country—the warmth engendered by the huddling colony arousing one or more of its members from their lethargy for the time. Woodchucks hibernate in pairs, but I never knew one of these proverbially sleepy creatures to leave its hole until warm weather came—in spite of the alleged practice it has of coming out invariably on the second day of February to fix the weather for the rest of the winter. I took the trouble once to dig into a woodchuck's burrow on a Candlemas Day—and a warm, cloudy day it was; just such a day when the groundhog is said to come out of his hole and stay out. I found two woodchucks in the burrow, with no more sign of life about them than if they had been shot and killed. From all outward appearances I could have taken them out and had a game of football with them without their knowing it.

Squirrels are only partial hibernators, from the fact that they work all summer and fall storing great quantities of food to supply them when hunger wakes them up during the winter, if, indeed, they spend much of their time in sleep. Squirrels are systematic and longheaded providers for the emergencies of a long winter, and not only stow away their favorite food in one grand storehouse, but also make deposits of it in other places, so that if one granary or nuttery is destroyed or becomes exhausted the caches can be depended upon. When the snow has lain on the ground late in the spring, holes may be seen in it at various places in the woods where squirrels have dug down through it to reach nuts or grain or acorns buried in the ground there months before for just such an emergency. The instinct with which these little animals locate such spots, covered as they are with maybe a foot or more of snow, is unerring and marvelous. If the snow should happen to be thickly covered with crust, the squirrels are unable to dig through it, and it is no rare thing, toward the end of an unusually long winter, for woodsmen to find squirrels dead on the crust, where they had been digging desperately to uncover the cache below, the supplies of the main store having become exhausted.

A curious phenomenon of hibernation, according to Prof. Browne, is shown in an animal called the loir, a native of Senegal. This animal never hibernates in its native clime, but every specimen that was ever brought to Europe became torpid as soon as exposed to cold. The common land tortoise, no matter where it may be, and it is a voracious feeder, goes to sleep in November and does not wake up again until May. The hedgehog goes to sleep as soon as the weather gets cold and remains in unbroken slumber six months.

At the beginning of cold weather bats begin to huddle together in bunches in hollow trees, dark corners in deserted houses and in caves and crevices in the rocks. They gradually lose all sensibility, and continue in a comatose state until the return of genuine warm weather. When you see the first bat of the season fluttering at nightfall, you can be sure that warm weather has come to stay. The little hooks at the end of one of the joints of each wing are what the bat hangs itself up by when it goes to sleep, whether for a day or for months. When the bats are clustering for hibernation, one of the number hangs itself up by its hooks, head downward, and the others cling to it. It is on record that sixty bats have been found in one cluster, the entire weight of the lot being sustained by the one bat clinging with its hooks to whatever it had fastened them to at the start—a weight of at least ten pounds. The position of the central bat in such a cluster would be like that of a man hanging to something by his thumb nails, and supporting the weight of fifty-nine other men. So completely is animation suspended in the bat during the cold months that no test yet applied has induced it to show the least sign of life. Torpid bats have been inclosed by the hour in air-tight glass jars and not a particle of the oxygen in the jars has been exhausted when they were taken out, showing that the bats had not breathed.

As cold drives certain animals, insects and reptiles to a state of torpidity, so heat and lack of water bring about the same condition in others. The animal or reptile that hibernates or goes to sleep in cold weather arranges its body so that it will conduce to the greatest warmth, while those that estivate, or become torpid in warm weather, place themselves in positions that show that they want all the coolness the climate will permit. The tenric, a tropical animal, carnivorous and insectivorous, becomes torpid during the greatest heat, and lies on its back with its body drawn to its greatest length and its limbs spread wide apart. Snakes estivate in the South, all kinds together, just as snakes hibernate in the North, but instead of rolling them-

selves in great balls, as the Northern snakes do, they lie singly, and stretched to their full length.

Want of water will cause the common garden snail to go into a state of the most complete and curious lethargy. This is the snail of the genus Limax, and not the larger one of the genus Helix. In the latter the phenomenon of hibernation is especially remarkable. In November the snail forms just a soft, silky membrane across the external opening of its shell. On the inner surface of that it deposits a coating of carbonate of lime, which immediately hardens like gypsum. This partition is again lined with a silky membrane. The snail then retires a little further into the shell and forms a second membraneous partition, retiring again and again until there are six of these partitions between the snail and the lime-coated door at the entrance of the shell. In the recess behind all these partitions the snail lies torpid until May. All this time it lives without motion, without heat, without food, without air, and without circulation; without the exercise of any of its functions. If this snail is prevented from hibernating for several seasons, by keeping it in a warm room, it will gradually waste away and die. Prof. Browne mentions a case where several snails of this genus were shut in a perforated box without food or water. They retired into their shells and closed them with a thin membrane. They remained so for three years. They revived when put into tepid water. They had been driven into torpidity by drought. The blood of this snail is white.

Another curious thing about hibernating animals is that the bile of all other animals is the bitterest of substances, while the bile of hibernating animals is sweet. —New York Sun.

A HUMBUG—ART VERSUS NATURE.

By GEORGE ARCHIE STOCKWELL.

HEREWITH are presented three cuts (Figs. 1, 2 and 3) made from photographs taken of a pretended lusus na-

FIG. 1.

ture said to have been captured in Matanzas Inlet, Florida.

When the "counterfeit presentments" were first viewed, I naturally called to mind the handiwork of certain Japanese artists, whereby are prepared for market "mermaids." These consist either of the body of a monkey and that of a fish so adroitly joined as to almost defy detection, or of a wooden body carved in grotesque semblance of the upper part of the human form and an actual fish continuation replacing the hips and legs (Fig. 4). The gentleman who sent me the first photograph (Fig. 1) was informed the creature "had been pronounced by eminent doctors and naturalists

FIG. 2.

as a connecting link between the birds and fishes;" and also that it had "never been described or figured in any work of natural history, though Webster, in his Unabridged Dictionary, describes it in part as a 'sea devil.'"

It may here be remarked that Webster describes a "large cartilaginous fish of the genus Cephaloptera" as a "sea devil," which term he likewise applies to the Lophius piscatorius, variously known in different localities as the "angler," "angel fish," "toad fish" and "fishing frog."

Subsequently from the same source were derived photographs, from which are taken Figs. 2 and 3.

Repeated attempts on my part to define the creature by the aid of the most modern works devoted to ichthyology proved futile. There could be found nothing that in any way applied to the form or outline as displayed in the photographs. Latterly, during a correspondence with Mr. Henry J. Scherck, this gentleman informed me that during the past summer he observed "on what is called the pier at Atlantic City, N. J., two or three of these creatures nailed to a post." He adds:

"The fish is flat; the rudimentary legs in those seen by me were not quite as long as represented in the photographs; the drying and mounting in a standing position gives a peculiar appearance. The tail is long and resembles to some extent that of the creature known as 'stingaree.'"

Mr. C. H. Eigersmann, who has been associated with Prof. David S. Jordan in the publication of "North American Fishes" (Government Printing Office, Washington), when the photographs were submitted to him, unhesitatingly pronounced the creature "a fraud." He further says:

"No such creature as figured ever existed, now exists or ever will exist. It is, if anything, of the skate family. I have seen sailors tie back the pectoral fins of a skate, force a pipe between its teeth and hang it to a post. In this condition the appearance is such that the openings of the nose have the position of eyes, and there is a resemblance to the human face—not a remarkable fact, considering that the imagination sees human faces in the most unlikely objects."

A correspondence with Dr. W. D. Hutchings, of Madison, Ind., brought out information that leads me to definitely place the creature in the sub-order of fishes denominated Masticura, which embraces the rays and skates, of which more than two dozen are known to American waters. In order to market it among curiosity seekers, the fishermen, immediately after capture, mutilate and alter the creature in shape

FIG. 3.

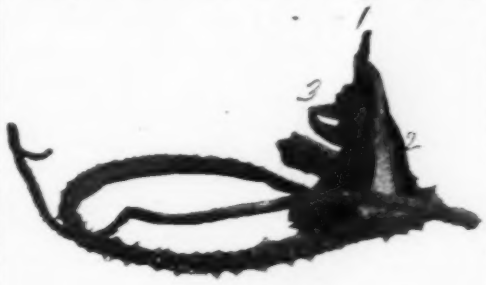


FIG. 5.

and outline, producing the form appearing in Figs. 1, 2 and 3. A large portion of the tail is first amputated —normally it should be nearly or quite three feet in length, and it and the body are covered with sharp bony spines or points. Next the integument covering the upper jaw is dissected up at point 3, Fig. 5, and reflected back and drawn into shape to form the peak at the top of the head (point 1, Fig. 5), and allowed to dry in this position. The integument of the under portion of the jaw, together with that of the throat and the upper breast, is also dissected back at point 2 in both Figs. 5 and 6, and when dried, forms the wings. A like process on the posterior and under portion of the body close to the tail forms the suppositions hips and legs.

Fig. 6 represents the creature very nearly intact.

If this is not the form of ray known as "whiparee," it certainly is closely allied thereto. When the foregoing facts are known, Fig. 3 becomes a trifle more intelligible, as close scrutiny reveals the original outline of the ray and the grooves formed by the tissues when reflected back. I am not positively certain, but surmise this to be either the Urolophius jamaicensis or the Dasytis sabina.

Perhaps some of the Southern readers of the SCIENTIFIC AMERICAN SUPPLEMENT can throw more light upon this subject.

FIG. 6.

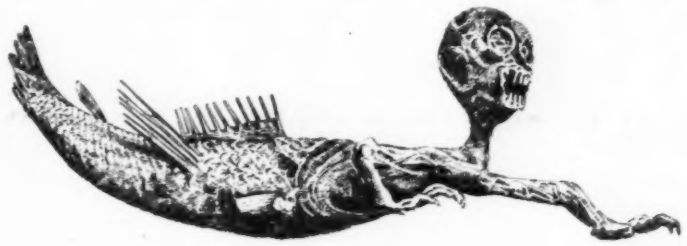


FIG. 4.

EDUARD LINDEMANN AND OSCAR STUMPE.

THE last days of the old year witnessed the removal by death of two astronomers who have rendered valuable services in the respective positions in which they were situated, though not occupying prominent places in the history of the science. Both are mentioned by the authorities under whom they served with the utmost respect, and their loss is acknowledged with profound regret.

Dr. Eduard Lindemann, who died suddenly on December 21, was born in Nishni-Novgorod in 1842, and pursued his scientific studies in the universities of Kasan and Dorpat. The latter university he left in 1868 to enter the observatory of Pulkova, wherein he filled the office of scientific secretary. In this capacity he had the management of the library, and the preparation of the second part of the "Librorum in Bibliotheca Speculæ Pulkovensis contentorum Catalogus systematicus" was intrusted to him, and very admirably did he fulfill the trust. The duties of his office did not permit him to take a great part in the astronomical observations there carried on; but his tastes led him to take great interest in the Zöllner photometer, and the series of careful measures which he made with that instrument have led to his being regarded as an authority in its use. His paper on the "Brilliancy of Bessel's Stars in the Pleiades," published in tome xxxii of the Mem. de l'Acad. Imp. des Sci. de S. Petersbourg, is well known, and he has further used his measures to determine the scale of magnitude employed in the Bonn Durchmusterung.

The second astronomer whose death (at the early age of thirty-five) we have regretfully to mention is Dr. Oscar Stumpe, well known for his contribution on the motion of the solar system. Dr. Stumpe's early life appears to have been one of great hardship and a severe struggle against adverse circumstances. When ten years old he lost his father, but in face of all difficulties, he determined to win his way to the Berlin University as a student of science. This he accomplished in 1883, though he had had occasionally in previous years to interchange the parts of student and teacher in order to obtain a livelihood and be enabled to continue his career. Even at Berlin, his studies of mathematics and astronomy were interrupted by his duties as a shorthand writer in the government and law courts. From Berlin he went to Bonn, and became a teacher in a private institution. Here he appears to have prepared the heavy calculations which he afterward incorporated in his inaugural dissertation on the solar motion. In this work, Dr. Stumpe based his computations on 1054 stars, whose annual proper motion exceeded 0·16″ in the arc of a great circle. The peculiar feature in the treatment was the introduction of a term depending upon a supposed orbital motion of the stars in the plane of the Milky Way. This term did not appear, however, to have a real existence. The stars were divided into four groups depending upon the amount of the annual proper motion, and the four solutions gave very accordant results in R. A. for the position of the apex of the solar system. The declination appeared less certain, but great confidence has been attached to the results of this particular investigation. Dr. Stumpe's talents as a computer have been generally recognized. He took some share in the calculations of the star places in the Bonn Zone Catalogue under Prof. Deichmuller, and after-

ment is automatically recorded on a strip of photographic (blue print) paper.

The original working model is shown in Fig. 3, part of the outer cylinder being cut away to illustrate the method of operation. A is a circular brass case inclosing a strong eight day clock movement and rigidly mounted on the adjustable metal support, B. The clock turns the outer cylinder, C (which is also of brass), once in twenty-four hours, and keeps the differential bright and black bulb thermometer of glass, D, constantly exposed directly toward the sun. The cap, c, closes the lower end of the cylinder, C, perfectly tight, and is held in place by friction. The cylinder itself is secured to the clock pinion by the set screw, s, and is removed entirely when a new sensitized sheet is to be put in place. Directly behind the central stem of the differential thermometer a narrow slot is cut through the cylinder, C, so that it will be completely covered by the mercurial column as it rises with the increasing intensity of sunshine. The strip of sensitized photographic paper is wrapped around the circumference of the part, A, and is held in place by suitable clips.

This apparatus is placed in a position where it will receive the sun's rays at all hours of the day and at all seasons of the year, the cylinder, C, being parallel with the axis of the earth. Ordinary blue print paper is used, and is attached to the case, A, with the upper edge of the sheet under a fixed projecting piece of thin brass having the hours perforated therein and indicated by notches or holes at accurate distances apart. It will be seen that, as the cylinder, C, revolves with the sun, the instrument will automatically record its own time marks on each sheet. Furthermore, by stretching fine wires across the slot behind the mercurial column, the horizontal record lines for the scale of varying intensities of sunshine will be photographed in white. The differential bright and black bulb thermometer, D, is made similar to the present Weather Bureau thermometric sunshine recorder (Fig. 2), except that each bulb is in an independent vacuum. The glass tube is attached rigidly to the cylinder, C, and cemented in place so that the cylinder is watertight. The weight of this glass part is counterbalanced by the weight, W, so as to insure a regular rate for the clock.

This photo-thermo recorder is, of course, capable of being much improved as regards mechanical construction. Without adding much to its size or cost, it can readily be made to produce an entire week's record, which is very desirable. The inexpensive American clocks are strong and sufficiently reliable timekeepers for the out-of-door conditions to which an apparatus of this kind must necessarily be exposed. Still, if the clock is unsatisfactory, the cylinder could be revolved by suitable mechanisms operated by electricity. The differential thermometer could also be made electrically recording, as at present, without interfering with the photographic record of intensity. One of the advantages of a photographic recorder operating on this principle is that the sensitized paper is securely inclosed and protected in a watertight case, and the records cannot be affected by rain and dampness, as in the present forms of these recorders. A more delicate and sensitive paper can therefore be safely used. Another advantage is that it uses the plain, blue print paper, which can now be procured almost everywhere of dealers in photographic supplies, which paper is generally of far greater excellence than any that can be made in small quantities by hand.

Information relative to the intensity of solar radiation has been urgently needed for many years in the study of sanitary climatology and in investigations as to growth of crops and agricultural interests generally, and it is hoped this article may lead either to the perfection of present forms of sunshine recorders or to the invention of something new that will furnish this important factor in our meteorological problems.

MODERN VIEWS OF THE RAINBOW.*

DESCARTES' theory of the rainbow, which is still found in all optical textbooks, is hardly even a rough approximation to the true theory. It does not fully explain the ordinary bows, and fails entirely as regards the "spurious bows," improperly so called. Any close observer will, under favorable conditions, notice certain colors on the inside edge of the primary bow which are not consistent with the simple series of spectrum colors demanded by the venerable theory which may be said to mark the birth of modern science. These additional colors, chiefly red and green, recall the colors seen in Newton's rings at some distance from the center, and at once suggest a similar origin. In a paper on "The intensity of light in the neighborhood of a caustic" (Trans. Camb. Phil. Soc., 6, 1838, and 8, 1848), Airy has laid the foundation of an adequate theory of the rainbow which is gradually being worked out. With a considerable amount of patience, Mr. J. M. Pernter has calculated the tints and the angular deviations of the rainbow colors for various sizes of raindrops, and has devised experiments in support of his deductions. A parallel beam of sunlight after reflection and refraction in a spherical raindrop does not emerge as a parallel beam, or as a bunch of parallel beams of various colors, but as a series of caustics of somewhat complicated nature, in which the divergence of the colors, and hence their distinctness, separation or coincidence, depend upon the ratio of the radius of the drop to the wave length of the light. The influence of size is very formidable in the smaller drops, say of 0·01 mm. radius. This would be a very fine spray. The actual size of raindrops is supposed to vary between 0·1 mm. and 2·6 mm., but the heavy drops of tropical rains are said to attain diameters of 3·4 mm. Their size may be estimated by catching and weighing a definite number, or by the more difficult method of diffraction. The tables drawn up by Pernter consider drops of twelve different sizes between 0·005 and 1 mm. radius. In order to determine the resulting colors, Pernter selects eight of Maxwell's twenty-two color equations, which number he finds sufficiently accurate. The first set of his tables state, for a point source of light, the sequence of colors, their composition in terms of red, green and violet, the relative intensity (admixture of white, after Abney) and position on the color triangle of each shade for various deviations between 42° 20' and 36°. These tables are then verified by experiments with cylindrical streams of drops according to Babinet's method. With 1 mm. drops, Pernter observed red, orange-yellow, green, violet, blue, second violet, and then twenty-four secondaries or spurious colors, chiefly pinkish-violet and green or blue; after the twelfth violet came a whitish band, and then a reversal in the sequence of the colors. The 0·5 mm. drops gave 11 bows with 40 shades. The outer bow and its secondaries were also observed. Verifications in nature are hardly possible, as we cannot measure simultaneously the angles and the size of the drops producing the bow; it is striking, however, that so very few angular measures are extant.

The white or pale rainbows (fog or mist bows) around moon and sun may appear pale owing to (1) the feeble intensity of the light, (2) the uneven size of the drops, and (3) the mixture of colors. The first cause is probably a real one; the second Pernter is inclined to reject, since the accompanying, often well-defined features such as "glories," Brocken spectra, etc., and also his own tests require homogeneous conditions. As regards the third, Abney has proved that all colors of any shade disappear on being diluted with 75 parts of white, and Pernter's tables show that such cases may well occur. Further, Airy's theory renders white bands possible for all sizes of drops, and necessary for radii below 25 μ. As a stream of water of such fineness cannot be maintained, Pernter produced a mist spray by fixing a 0·5 mm. glass tube in a lead pipe connected with the Innsbruck water mains (pressure 5 atmospheres), and directing the jet against a metallic plate; the size of drops was derived from measurements of diffraction rings. Drops of radius 5 μ gave a yellow margin at 41° 59', white between 41° 8' and 38° 27', and then blue to 37° 41'; larger drops were more difficult to manage. From measurements of fog bows on Ben Nevis, J. McConnell had in 1890 already calculated the sizes of the respective drops. But some of these observations speak of a red outer margin, for which Pernter looked in vain, and which his calculations do not indicate; Crailheim-Gyllenskiöld (Swedish North Pole expedition, 1882) also describes the margin as of other color. The classical white bow of Bouguer (1744) and of Scoresby (1821), however, do not fit into the theory at all, and were probably due, as the observers remarked, to ice needles.

The general conclusions are interesting to meteorologists. The greater the drops, the more secondaries (spurious bows). A chief bow of intense pink and green (hardly any blue) indicates drops of diameters ranging from 1 to 2 mm.; intense red always speaks for big drops. Secondaries of green and violet (the blue is masked by contrast) without yellow, immediately joining the chief bow, correspond to drops of 0·5 mm., while five and more secondaries without white and without breaks mark drops of 0·1 mm. A partly white bow is produced by drops of 0·06 mm., and when the drops are still smaller, a real white bow with orange-yellow and blue margins is the result. The net result of these elaborate investigations will be to add a new interest to a natural phenomenon already endowed with many associations of magic and beauty.—Nature.

* See a paper by J. M. Pernter, Wien. Ber., 106, part 2, a, 1897, and Abstracts of the Physical Society, No. 86.

EFFECT OF THE "BORA" IN DUGA PASS, MONTENEGRO.

FROM A DRAWING FROM NATURE BY PROF. FRANZ SVERINA.

THE EFFECT OF THE "BORA" IN THE DUGA PASS, MONTENEGRO.

WE publish to-day a reproduction of a drawing by Prof. Franz Sverina, from which our readers can gain some idea of the terrible work done by the "bora," a violent and bitterly cold northeast or east wind that prevails along the eastern coast of the Adriatic Sea at certain seasons of the year. It is supposed to be caused by a disturbance of the warm air over the sea and the rush of the colder air from the land to take its place as it rises. The bora sometimes prevails for days, and, according to careful observations made in Trieste and Fiume, attains a velocity of fifty miles, or more, an hour, but its greatest danger lies in the suddenness with which it rises and the fitful manner in which it blows. There is no infallible sign of its approach. The sky will be clear and blue, there will be no bank of clouds on the horizon, the only indication that a storm

is brewing being a thin horizontal cloud about the tops of the highest mountains, which the inhabitants of that country call the "signal." The atmosphere at these times is most healthful and invigorating, and the natives find it much more bearable than the conditions which accompany the sirocco, when the air is damp, warm and depressing.

It is interesting to see how all forms of life in the region visited by the bora adapt themselves to the temper of their stormy guest. Trees and shrubs never grow very high, and their branches spread in a southerly or southwesterly direction, even the stems of plants incline that way, and men have, of course, learned to build their houses so that they will offer a safe shelter during the storms. The roofs, which are heavily loaded with stones, project only on the southern and southwestern sides, and the doors and windows open in the same directions. But, in spite of this, the wrath of the storm always demands some sacrifices of men and animals who are overtaken by it in such places as the Duga Pass, shown in our engraving (for which we are indebted to the Illustrirte Zeitung), in which we see animals that, while on the steepest and most dangerous part of the pass, perceived the approach of the bora, became more and more restless, pressed close together, and finally broke away and rushed down the steep path, seeking the safety offered by the valley; but the malicious bora surprised many on the dizzy heights, and woe to all who were unable to find shelter in nooks in the rock or to obtain a hold of any kind; they were swept off like chaff and hurled into the abyss. There is a never-ending struggle between the inhabitants of the Black Mountains and the overwhelming forces of nature, and yet these people are devotedly attached to their rugged home, which was the last refuge of the old Servian freedom that was swept away by the Ottomans, whose attacks were as devastating in one way as those of the bora are in another. In former times this pass often resounded with the clang of the weapons of Ottomans and the Montenegrins, and it is still an important military stronghold with many fortifications.

M. Camille Flammarion has undertaken to cinematograph the sky. He takes 3,000 photographs a night when it is clear and expects to show realistic pictures of the movements of moon and stars.

FALIZE'S BUST OF GALLIA.

FALIZE'S bust of Gallia is now in the gallery of sculpture of the Luxemburg Museum. Before the last arrangement of the pictures and statues, it was placed in the center of the first hall of paintings. Behind it were displayed the rich showcases of goldsmith's work and enamels; and in the opinion of its designer it here found a normal vicinage. In executing it after the original of M. Moreau-Vauthier, master goldsmith Lucien Falize had, in fact, but one pretension: "I have desired," said he, "to produce a piece of trade work which should prove that, as regards style, our skill is abreast of that of the best epochs of art."

The head of Gallia is carved from a piece of ivory and surmounted by a gold helmet enriched with emeralds and rubies. The chest is covered with a coat of mail of old silver held by straps of gold, and upon the shoulders are lions' faces having emerald eyes. A series of leather straps stamped with gold detach themselves from the helmet and fall around the neck. The decoration is strengthened by motifs of expression; the helmet in the form of a dolphin's head surmounted by a dragon, and a head of Medusa placed upon the breast in the center of the armor. Such as it is, this bust could, in fact, find terms of comparison only among similar works, the products of the goldsmith's art.

BUST OF GALLIA BY LUCIEN FALIZE.

But since its present place in the gallery of sculpture constitutes a presentation of honor, it would be impossible to find fault with a homage that is addressed as much to the original bust by Moreau-Vauthier as it is to Falize's work of interpretation, and, through it, to our decorative art, of which goldsmith's work is one of the most legitimate representatives.

Among the many productions of Falize, amateurs hold principally in esteem "Urania's Clock," in gold, ivory and enamel; the "Angelus Clock," in ivory and gold, in the style of the twelfth century; the "Sassanida Vase," in rock crystal, gold and enamel; the "Ship of Peter the Great," belonging to Grand Duke Vladimir; the "Billow," an epergne in massive silver; the "Crown," which the Czar deposited upon Carnot's tomb; the "Hammer and the Trowel" of the Alexander III bridge; the "Mortuary Crown" of Duc d'Aumale; the four panels of Prince de Bearn (Gaston de Bearn, Gaston de Foix, Anne de Bretagne and Marguerite de Navarre); the "Olive Crown," of fine gold, which President Felix Faure deposited upon the tomb of Alexander III; and the "Three Coronations," one of Falize's most valuable works, for which the museums of Kensington and Berlin are now disputing.

The "Goblet of the Decorative Arts" worthily terminates both this series of pieces and a career which signalized itself by the restoration of mosaic work in enamels and of bass-relief enamels to a place of honor, and by the creation, in practical order, of a syndical chamber of goldsmith's work.

If Falize had not been taken away from us so prematurely a few months ago, some new projects, bolder still than the "Goblet," would have seen the light for the Exposition of 1900, and have affirmed anew the artistic law formulated in the report upon the class of goldsmith's work at the Exposition of 1889. The rosette of officer of the Legion of Honor that Falize received on this occasion had been valiantly won; and although the master goldsmith did not realize all his ideas, he produced enough to save his name from oblivion.—Le Magasin Pittoresque.

THE MAGNETIC PROPERTIES AND ELECTRICAL RESISTANCE OF IRON AT HIGH TEMPERATURES.*

THE magnetic properties of iron and, to a lesser extent, of the associated metals—nickel and cobalt—have always been a fascinating subject of study. Possessed by these three metals alone, these properties, so peculiar and so different from any of the other known properties of mater, have imparted to the study of these so-called magnetic metals a special charm and interest, apart from that excited by the vast industrial importance of at least one of them.

Among the very early inquiries into the nature of magnetism there were not neglected experiments on the effect produced by change of temperature. Three centuries ago Gilbert recorded the observation that a piece of iron or steel, if heated more strongly than up to a full red heat, ceased to be attracted by a magnet, though it regained its previous magnetic qualities on cooling below that temperature.

Until comparatively recently, however, accurate magnetic measurements, even at ordinary temperatures, could alone be made on permanent magnets and the forces acting on their poles. The capability of acquiring temporary or induced magnetism when near a magnet, which is the characteristic property of soft iron, could not be subject to strict measurement until it was shown, first, how a given specimen of iron could be uniformly magnetized in a uniform magnetic field; and, secondly, how both the magnetizing force of that field and the consequent magnetization of the iron could be measured. We know of only one way of completely satisfying the first condition, namely, by covering a ring-formed specimen (whose outer diameter but slightly exceeds the inner) with a uniform layer of insulated wire carrying an electric current, thus forming a ring magnet with no disturbing poles. And Faraday's researches on electro-magnetic induction have furnished us with a method, at once accurate and convenient, of determining the magnetization of the apparently unmagnetized ring magnet, i. e., by the use of a "secondary winding" or outer layer of insulated wire connected with a "ballistic" galvanometer. Knowing, then, the intensity of magnetization called up by a given magnetizing force, we can, from their ratio, express the facility with which the iron takes up magnetic induction, or, in other words, its magnetic permeability.

To apply this method to the measurement of permeability at high temperatures, both the magnetizing and the secondary winding must be so insulated as to be uninjured by the heating; and, further, the thermometer or pyrometer, which measures the temperature, must be placed inside the ring, so as to measure the actual temperature of the iron.

Among the earlier important researches on magnetic properties at high temperatures, that of Baur, of Zürich, in 1879, should be mentioned. He experimented simply on an iron bar heated in a furnace, and thence rapidly transferred to the interior of a straight magnetizing coil. Not, however, till 1889 was it shown by Dr. Hopkinson, in his classical researches, that the ring-magnet method could be successfully applied to the measurement of permeability at high temperatures. The windings of the ring magnets were, in this case, of copper wire insulated with asbestos; the heating was carried out in a gas furnace, and the rise of temperature of the iron core was deduced from the increase of the electrical resistance of the secondary winding.

Of the more recent researches, the most remarkable is that of M. Curie, published in 1895, describing experiments on the magnetic behavior of a great variety of substances at temperatures ranging up to a white heat. The method he adopted—that of finding how strongly the specimens were attracted when placed near a powerful magnet—was well adapted to determine permeability in intense magnetic fields, but it is much inferior to the ring-magnet method, where the permeability varies much with the magnetizing force, as is the case whenever the magnetic field is not intense.

In the course of some experiments on the subject of this article, the results of which have been recently published, I have endeavored to approximate, where possible, more closely than previous experimenters to the ideal method which would be the outcome of the principles laid down above. The ring magnet, whose core was the iron specimen to be tested at high temperatures, was made very small, measuring about one inch across. The temperature of this core was determined by means of an electrical thermometer embedded in it, consisting of a wire of pure platinum whose electrical resistance at any temperature had been previously determined, and whose resistance, therefore, if subsequently measured, gave its temperature, and hence, also, that of the iron core in which it was laid. Asbestos paper insulation, as had been used by former experimenters, was found to be very imperfect at high temperatures, owing largely to carbon deposited from the materials used in its manufacture. This difficulty was, after some trouble, overcome; but wherever a high degree of insulation was wanted, as in the case of the thermometer wire and secondary winding, it was found necessary to employ mica, though, as may well be imagined, the use of such an untractable material for such

* David K. Morris, in Nature.

a purpose is beset with considerable mechanical difficulties.

Now, to find the magnetic condition of a sample of iron at a given temperature with any completeness, it is not sufficient merely to measure its permeability in various magnetic fields; the behavior of the iron when subjected to what is called a "cyclic" process of magnetization must be studied—the "hysteresis" or energy absorbed in one double reversal of the magnetization of each cubic centimeter of the iron must be measured.

But the taking of so many observations requires time; and if, during this time, the temperature of the iron be not perfectly constant, all efforts at refinement in the magnetic measurements are thrown away. The heating of the ring must, then, be thoroughly under control. The method I adopted was an electrical one. The ring magnet was furnished with an extra winding of asbestos-insulated platinum wire, so wound as to have no magnetizing influence; and by passing through this wire a suitable electric current, heat could be generated in the ring at any desired rate. This method, however (the principle of which was adopted as long ago as 1888 by M. Ledeboer), is not used to full advantage unless combined with an effort to thermally isolate the body to be heated. Each ring magnet was, therefore, thickly wrapped with asbestos and supported in the center of a closed and partially exhausted glass vessel (oxidation of the iron core was also in this way avoided).

This method of heating proved most satisfactory. The loss of heat by radiation and conduction being slight, the ring magnet could not rapidly alter its temperature; and there is probably no way in which we can supply heat energy to a body which can compete with the electrical resistance method, either as regards constancy or control. For obtaining temperatures up to 1,300° or 1,400° C.—a white heat—this method, combined as far as possible with "thermal isolation," and an electrical method of measuring the temperature, should in the future prove of the greatest value in all cases where the physical properties of bodies at high temperatures require careful investigation.

The original intention of my experiments was to ascertain exactly in what way the specific electrical resistance of iron changes at and about the "critical temperature" at which the magnetic properties of iron so nearly disappear, so as to throw light, if possible, on the molecular state which we characterize by the term "magnetic." With this object, the iron core of the ring magnet was formed of a long insulated iron strip, among the turns of which the platinum thermometer wire was buried; and with this piece of apparatus simultaneous measurements of the magnetic qualities and electrical resistance of a sample of iron could be made with accuracy alike at low and high temperatures.

Let us now consider the magnetic changes which occur in soft iron when heated. At ordinary temperatures iron shows a kind of unwillingness, so to speak, to become slightly magnetized—its permeability under small forces is not great. Beyond a certain limit, however, it exhibits the greatest readiness to become further magnetized, and continues to have a high permeability until magnetized very strongly. But from this point it begins to show signs of magnetic saturation, and ultimately refuses to be further magnetized without the application of very great force.

Now, as the temperature of the iron is gradually raised, it is found that practical magnetic saturation takes place sooner and sooner. Iron refuses to become so strongly magnetized at higher temperatures. Thus the permeability in strong magnetic fields falls off as the temperature rises, very slowly at first, then more rapidly, till, near the "critical temperature," the permeability rapidly drops to quite a low value.

On the other hand, in weak magnetic fields, the behavior of iron up to within a few degrees of the "critical temperature" is precisely opposite. The permeability rises with the temperature, at first slowly, then above 500° C. with ever increasing rapidity, until at last that lack of susceptibility to small forces disappears, and iron shows itself just as amenable to magnetic influence in small magnetic fields as in the larger ones, where the maximum permeability occurs.

At this temperature, say 15° below the critical temperature (about 750° C.—a red heat), iron possesses all those qualities at once which are sought after by the transformer maker—practical absence both of hysteresis and of eddy currents (the latter owing to the greatly increased electrical resistance), and a permeability nearly four times as great as that attainable in commercial transformer iron. So magnetic, indeed, is the iron that even the earth's magnetic field, in the direction of its greatest intensity, is enough to induce strong magnetization (B = 5,000), in fact, almost saturate the iron (for which, at this temperature, a relatively low induction suffices). The behavior of a compass needle near a slowly cooling ingot of cast steel should be rather interesting, for just below the critical temperature the vertical ingot must behave as a very powerful magnet indeed.

For all the lesser magnetic fields, there is a temperature of maximum permeability which is nearer to the critical temperature the smaller the magnetic field. But at that temperature the magnetic qualities in almost all fields practically vanish. Hence, when the magnetizing force is very small, the change from enormously magnetic to almost non-magnetic takes place with extreme suddenness.

Above the critical temperature iron is but feebly magnetic; yet it is still much more readily affected by a magnet than most other feebly magnetic bodies. Not till a white heat is reached do the magnetic qualities of iron become imperceptible.

It is not easy in an article like the present to deal with the changes which occur in the electrical resistance of iron, but the following remarks may be of interest:

The experiments of Dewar and Fleming have shown that at a temperature of −200° C. the specific electrical resistance of iron is extremely low. Throughout the range of temperature included between that extreme of cold and the critical temperature—about + 780° C.—the resistance rises at a steadily increasing rate, so that at the latter temperature it is over 150 times as great as at the former: far in excess of that of any known alloy at ordinary temperatures (crystalline metals and their alloys excepted), and about equaling liquid mercury for high specific resistance. On still further raising the temperature of the iron, it is found that the rate of rise of resistance, instead of further increasing very rapidly, falls off till, at a white heat, the resistance of iron increases only slowly with the temperature.

It has long been known that this increasing rate of rise of resistance with temperature is a characteristic possessed by the magnetic metals alone. Here now we see that no sooner does the iron cease to be strongly magnetic than this quality disappears and becomes exchanged for an opposite one, namely, a decreasing rate of rise of resistance with temperature. In some hitherto unpublished experiments on Hadfield's manganese steel (a non-magnetic steel which can be rendered magnetic by annealing), I have observed a precisely similar change of the resistance temperature function to take place during the annealing of this steel, thus furnishing a second case of this obscure resistance change accompanying the change from magnetic to non-magnetic in one and the same sample.

The connection between magnetic and electrical properties is evidently not a very simple one, but in the face of these facts it is hard to deny that there is one; and it is only by trying to find out how the various physical properties depend upon magnetism that we may hope to arrive at a comprehensive explanation of that obscure but most interesting condition of matter.

HIBERNATION.

THE phenomenon of hibernation in animals, fish, and reptiles is something that from its very nature and surroundings cannot be investigated, and consequently little is known as to its cause, or as to what physiological changes occur to animals that habitually retire to concealed places and lie dormant, or in a lethargic sleep, for days, weeks and even months. It is known that in the perfect hibernators the processes of nature are interrupted during the period of this long insensibility. Breathing is nearly and in some hibernators entirely suspended, and the temperature of the blood, even in the warmer blooded animals, falls so low that how life can be maintained by it is a mystery of mysteries.

A variety of Rocky Mountain ground squirrel, when in perfect hibernation, has a temperature only three degrees above the freezing point of water, and when taken from their burrows in that condition these squirrels are as rigid as if they were not only dead, but frozen. But a few minutes in a warm room will show that they are not only alive, but full of life. This interesting fact in natural history was first demonstrated by the late Andrew Fuller, of Ridgewood, N. J., to whom a friend in the West sent a pair of these squirrels. When the weather became cold, Mr. Fuller missed his pets one day. He supposed they had run away from his premises. Nearly a month later he found them by accident curled up beneath a pile of straw in one corner of an inclosure on his place. They were so cold and stiff that he supposed they were frozen to death. He carried them into the house to show his wife the fate that had befallen the poor little rodents in the harsh Eastern climate. While he and she were discussing the matter sorrowfully, the squirrels began to show signs of life, and shortly were frisking about the room as if they had not been apparently frozen stiff for weeks.

Mr. Fuller then knew that the squirrels had been in a state of hibernation, and it was such an extraordinary one that he put them out of doors again to let them resume that condition if they might, so he might investigate it further. They had no sooner got into the cold air than the lethargic state began to assert itself, and Mr. Fuller covered them with the straw. A month later he took their temperature and found it to be as I have stated—only three degrees above the freezing point of water. Again they came back to life and activity when placed in the warm room, but after a few hours showed plainly that they were being bereft of their natural winter sleep. Mr. Fuller turned them loose to find it again. They found it as before, and they remained in that condition until the warm weather returned in the spring, when they came out as chipper as if they hadn't lost a day or a meal.

As to the suspension of breathing in hibernators, the fact is proved sufficiently in the instances of the raccoon and the woodchuck. When they have laid themselves away for their winter sleep, they roll themselves up so comfortably and press their noses in such a peculiar position against their hinder parts that it would be an absolute impossibility for them to draw a breath. The popular backwoods belief is that the bear rolls itself up in this way and does not breathe, but, while the bear is classed as a perfect hibernator by naturalists, it breathes while in its lethargy, as its blow holes in the snow prove—holes melted in the snow beneath which the animal frequently stows itself away, under a covering of leaves, which holes frequently betray its presence to the woodsman.

The marmot family produces the soundest winter sleepers. When the marmot is in its peculiar state of hibernation the electric spark will not rouse it. The most noxious gases do not affect it in the slightest. If its temperature is raised above that at which the animal breathed in its natural state, it will die almost immediately. This is on the authority of the late Prof. Peter A. Browne, who at one time was connected with Lafayette College, and investigated the subject of hibernation and estivation further than any other scientist that I know of.

The hamster, a rodent common in northern Germany, is another animal that has its peculiarities as a hibernator. Prof. Browne mentions a hamster that was put into a box which was closed with earth and straw and placed where the cold was intense, but the hamster did not show any sign of becoming torpid. The box was then buried in the ground and was dug up after some hours, when the animal was found in a state of the most profound lethargy. And this hamster was kept in a room where there was no fire. The animal rolled itself up in a corner, but presently woke up and came out. It was in the best of health, but died in a few days—"suffocated," Prof. Browne declared, "because it could not have confined air."

Our own familiar wild animals, the bear, the raccoon, and the woodchuck—the groundhog of colloquial nomenclature—are classed as perfect hibernators because they store no food for winter, but have acquired a thick, fatty secretion between the skin and flesh, which, it is supposed, supplies them with sustenance. As a matter of fact, although dormant animals absorb fat, it does not enter into their digestive organs. The same fat absorption occurs when the animal is dead. If you kill a rabbit, or any other animal, and leave the entrails in it, the fat will disappear in a short time. Remove the entrails, and the fat will remain. Food introduced into the stomach of a hibernating animal or reptile will be found undigested at all stages of its lethargy. I say "introduced into the stomach," because it could get into the stomach of such a creature only by force or artificial means, for a hibernating animal invariably goes into its peculiar state on an empty stomach. Why? I do not know. That is one of the mysteries of the phenomenon. But the most mysterious of all things connected with hibernating animals is that, although bears and woodchucks are profound hibernators, they produce their young during their winter sleep.

The woodchuck is undoubtedly a perfect hibernator, and the female bear is, but the male bear is frequently roused from his winter sleep, and is found roaming about in midwinter. A bear hunt when the snow is deep and the cold intense is not an uncommon relief to the monotony of life in the backwoods, but the hunted bear is invariably a male. I have talked with scores of old and observant woodsmen, versed in the ways and haunts of wild beasts, but none has ever been able to say yet that he ever knew a female bear to be killed after the season for hibernation has come, and none has ever yet seen a gravid female bear. Where do the females go during that time, that they are never disturbed in their retreats? No one can say.

The raccoon is often gregarious in its hibernating, and it may be that for that reason it not infrequently comes forth from its snug quarters in the hollow tree and makes foraging trips about the country—the warmth engendered by the huddling colony arousing one or more of its members from their lethargy for the time. Woodchucks hibernate in pairs, but I never knew one of these proverbially sleepy creatures to leave its hole until warm weather came—in spite of the alleged practice it has of coming out invariably on the second day of February to fix the weather for the rest of the winter. I took the trouble once to dig into a woodchuck's burrow on a Candlemas Day—and a warm, cloudy day it was; just such a day when the groundhog is said to come out of his hole and stay out. I found two woodchucks in the burrow, with no more sign of life about them than if they had been shot and killed. From all outward appearances I could have taken them out and had a game of football with them without their knowing it.

Squirrels are only partial hibernators, from the fact that they work all summer and fall storing great quantities of food to supply them when hunger wakes them up during the winter, if, indeed, they spend much of their time in sleep. Squirrels are systematic and longheaded providers for the emergencies of a long winter, and not only stow away their favorite food in one grand storehouse, but also make deposits of it in other places, so that if one granary or nuttery is destroyed or becomes exhausted the caches can be depended upon. When the snow has lain on the ground late in the spring, holes may be seen in it at various places in the woods where squirrels have dug down through it to reach nuts or grain or acorns buried in the ground there months before for just such an emergency. The instinct with which these little animals locate such spots, covered as they are with maybe a foot or more of snow, is unerring and marvelous. If the snow should happen to be thickly covered with crust, the squirrels are unable to dig through it, and it is no rare thing, toward the end of an unusually long winter, for woodsmen to find squirrels dead on the crust, where they had been digging desperately to uncover the cache below, the supplies of the main store having become exhausted.

A curious phenomenon of hibernation, according to Prof. Browne, is shown in an animal called the loir, a native of Senegal. This animal never hibernates in its native clime, but every specimen that was ever brought to Europe became torpid as soon as exposed to cold. The common land tortoise, no matter where it may be, and it is a voracious feeder, goes to sleep in November and does not wake up again until May. The hedgehog goes to sleep as soon as the weather gets cold and remains in unbroken slumber six months.

At the beginning of cold weather bats begin to huddle together in bunches in hollow trees, dark corners in deserted houses and in caves and crevices in the rocks. They gradually lose all sensibility, and continue in a comatose state until the return of genuine warm weather. When you see the first bat of the season fluttering at nightfall, you can be sure that warm weather has come to stay. The little hooks at the end of one of the joints of each wing are what the bat hangs itself up by when it goes to sleep, whether for a day or for months. When the bats are clustering for hibernation, one of the number hangs itself up by its hooks, head downward, and the others cling to it. It is on record that sixty bats have been found in one cluster, the entire weight of the lot being sustained by the one bat clinging with its hooks to whatever it had fastened them to at the start—a weight of at least ten pounds. The position of the central bat in such a cluster would be like that of a man hanging to something by his thumb nails, and supporting the weight of fifty-nine other men. So completely is animation suspended in the bat during the cold months that no test yet applied has induced it to show the least sign of life. Torpid bats have been inclosed by the hour in air-tight glass jars and not a particle of the oxygen in the jars has been exhausted when they were taken out, showing that the bats had not breathed.

As cold drives certain animals, insects and reptiles to a state of torpidity, so heat and lack of water bring about the same condition in others. The animal or reptile that hibernates or goes to sleep in cold weather arranges its body so that it will conduce to the greatest warmth, while those that estivate, or become torpid in warm weather, place themselves in positions that show that they want all the coolness the climate will permit. The tenric, a tropical animal, carnivorous and insectivorous, becomes torpid during the greatest heat, and lies on its back with its body drawn to its greatest length and its limbs spread wide apart. Snakes estivate in the South, all kinds together, just as snakes hibernate in the North, but instead of rolling them-

selves in great balls, as the Northern snakes do, they lie singly, and stretched to their full length.

Want of water will cause the common garden snail to go into a state of the most complete and curious lethargy. This is the snail of the genus Limax, and not the larger one of the genus Helix. In the latter the phenomenon of hibernation is especially remarkable. In November the snail forms just a soft, silky membrane across the external opening of its shell. On the inner surface of that it deposits a coating of carbonate of lime, which immediately hardens like gypsum. This partition is again lined with a silky membrane. The snail then retires a little further into the shell and forms a second membraneous partition, retiring again and again until there are six of these partitions between the snail and the lime-coated door at the entrance of the shell. In the recess behind all these partitions the snail lies torpid until May. All this time it lives without motion, without heat, without food, without air, and without circulation; without the exercise of any of its functions. If this snail is prevented from hibernating for several seasons, by keeping it in a warm room, it will gradually waste away and die. Prof. Browne mentions a case where several snails of this genus were shut in a perforated box without food or water. They retired into their shells and closed them with a thin membrane. They remained so for three years. They revived when put into tepid water. They had been driven into torpidity by drought. The blood of this snail is white.

Another curious thing about hibernating animals is that the bile of all other animals is the bitterest of substances, while the bile of hibernating animals is sweet. —New York Sun.

A HUMBUG—ART VERSUS NATURE.

By GEORGE ARCHIE STOCKWELL.

HEREWITH are presented three cuts (Figs. 1, 2 and 3) made from photographs taken of a pretended lusus na-

FIG. 1.

ture said to have been captured in Matanzas Inlet, Florida.

When the "counterfeit presentments" were first viewed, I naturally called to mind the handiwork of certain Japanese artists, whereby are prepared for market "mermaids." These consist either of the body of a monkey and that of a fish so adroitly joined as to almost defy detection, or of a wooden body carved in grotesque semblance of the upper part of the human form and an actual fish continuation replacing the hips and legs (Fig. 4). The gentleman who sent me the first photograph (Fig. 1) was informed the creature "had been pronounced by eminent doctors and naturalists

FIG. 2.

as a connecting link between the birds and fishes;" and also that it had "never been described or figured in any work of natural history, though Webster, in his Unabridged Dictionary, describes it in part as a 'sea devil.'"

It may here be remarked that Webster describes a "large cartilaginous fish of the genus Cephaloptera" as a "sea devil," which term he likewise applies to the Lophius piscatorius, variously known in different localities as the "angler," "angel fish," "toad fish" and "fishing frog."

Subsequently from the same source were derived photographs, from which are taken Figs. 2 and 3.

Repeated attempts on my part to define the creature by the aid of the most modern works devoted to ichthyology proved futile. There could be found nothing that in any way applied to the form or outline as displayed in the photographs. Latterly, during a correspondence with Mr. Henry J. Scherck, this gentleman informed me that during the past summer he observed "on what is called the pier at Atlantic City, N. J., two or three of these creatures nailed to a post." He adds:

FIG. 3.

"The fish is flat; the rudimentary legs in those seen by me were not quite as long as represented in the photographs; the drying and mounting in a standing position gives a peculiar appearance. The tail is long and resembles to some extent that of the creature known as 'stingaree.'"

Mr. C. H. Eigersmann, who has been associated with Prof. David S. Jordan in the publication of "North American Fishes" (Government Printing Office, Washington), when the photographs were submitted to him, unhesitatingly pronounced the creature "a fraud." He further says:

"No such creature as figured ever existed, now exists or ever will exist. It is, if anything, of the skate family. I have seen sailors tie back the pectoral fins of a skate, force a pipe between its teeth and hang it to a post. In this condition the appearance is such that the openings of the nose have the position of eyes, and there is a resemblance to the human face—not a remarkable fact, considering that the imagination sees human faces in the most unlikely objects."

A correspondence with Dr. W. D. Hutchings, of Madison, Ind., brought out information that leads me to definitely place the creature in the sub-order of fishes denominated Masticura, which embraces the rays and skates, of which more than two dozen are known to American waters. In order to market it among curiosity seekers, the fishermen, immediately after capture, mutilate and alter the creature in shape

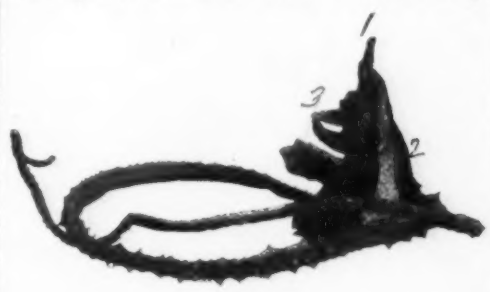


FIG. 5.

and outline, producing the form appearing in Figs. 1, 2 and 3. A large portion of the tail is first amputated —normally it should be nearly or quite three feet in length, and it and the body are covered with sharp bony spines or points. Next the integument covering the upper jaw is dissected up at point 3, Fig. 5, and reflected back and drawn into shape to form the peak at the top of the head (point 1, Fig. 5), and allowed to dry in this position. The integument of the under portion of the jaw, together with that of the throat and the upper breast, is also dissected back at point 2 in both Figs. 5 and 6, and when dried, forms the wings. A like process on the posterior and under portion of the body close to the tail forms the supposititious hips and legs.

Fig. 6 represents the creature very nearly intact.

If this is not the form of ray known as "whiparee," it certainly is closely allied thereto. When the foregoing facts are known, Fig. 3 becomes a trifle more intelligible, as close scrutiny reveals the original outline of the ray and the grooves formed by the tissues when reflected back. I am not positively certain, but surmise this to be either the Urolophius jamaicensis or the Dasytis sabina.

Perhaps some of the Southern readers of the SCIENTIFIC AMERICAN SUPPLEMENT can throw more light upon this subject.

FIG. 6.

EDUARD LINDEMANN AND OSCAR STUMPE.

THE last days of the old year witnessed the removal by death of two astronomers who have rendered valuable services in the respective positions in which they were situated, though not occupying prominent places in the history of the science. Both are mentioned by the authorities under whom they served with the utmost respect, and their loss is acknowledged with profound regret.

Dr. Eduard Lindemann, who died suddenly on December 21, was born in Nishni-Novgorod in 1842,

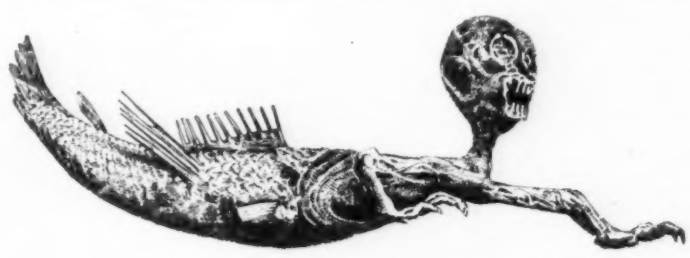


FIG. 4.

and pursued his scientific studies in the universities of Kasan and Dorpat. The latter university he left in 1868 to enter the observatory of Pulkova, wherein he filled the office of scientific secretary. In this capacity he had the management of the library, and the preparation of the second part of the "Librorum in Bibliotheca Speculæ Pulkovensis contentorum Catalogus systematicus" was intrusted to him, and very admirably did he fulfill the trust. The duties of his office did not permit him to take a great part in the astronomical observations there carried on; but his tastes led him to take great interest in the Zollner photometer, and the series of careful measures which he made with that instrument have led to his being regarded as an authority in its use. His paper on the "Brilliancy of Bessel's Stars in the Pleiades," published in tome xxxii of the Mem. de l'Acad. Imp. des Sci. de S. Petersbourg, is well known, and he has further used his measures to determine the scale of magnitude employed in the Bonn Durchmusterung.

The second astronomer whose death (at the early age of thirty-five) we have regretfully to mention is Dr. Oscar Stumpe, well known for his contribution on the motion of the solar system. Dr. Stumpe's early life appears to have been one of great hardship and a severe struggle against adverse circumstances. When ten years old he lost his father, but in face of all difficulties, he determined to win his way to the Berlin University as a student of science. This he accomplished in 1883, though he had had occasionally in previous years to interchange the parts of student and teacher in order to obtain a livelihood and be enabled to continue his career. Even at Berlin, his studies of mathematics and astronomy were interrupted by his duties as a shorthand writer in the government and law courts. From Berlin he went to Bonn, and became a teacher in a private institution. Here he appears to have prepared the heavy calculations which he afterward incorporated in his inaugural dissertation on the solar motion. In this work, Dr. Stumpe based his computations on 1054 stars, whose annual proper motion exceeded 0·16″ in the arc of a great circle. The peculiar feature in the treatment was the introduction of a term depending upon a supposed orbital motion of the stars in the plane of the Milky Way. This term did not appear, however, to have a real existence. The stars were divided into four groups depending upon the amount of the annual proper motion, and the four solutions gave very accordant results in R. A. for the position of the apex of the solar system. The declination appeared less certain, but great confidence has been attached to the results of this particular investigation. Dr. Stumpe's talents as a computer have been generally recognized. He took some share in the calculations of the star places in the Bonn Zone Catalogue under Prof. Deichmuller, and after-

ward, on repairing to Berlin in 1891, he was engaged in the preparation of the Zone Catalogue 15° to 20° declination. Since that time he has assisted Dr. Auwers in the many researches with which that astronomer has been connected, and who loses in him an able co-operator and a devoted assistant.—Nature.

A READABLE ACCOUNT OF THE MANUFACTURE OF LACTIC ACID.

IN the June 30, 1897, number of The Journal of the Society of Chemical Industry is a very interesting areticle by Alan A. Claflin on "The Manufacture and Applications of Lactic Acid." We cull from it such parts as may be of particular interest to our readers.

The lactic acid industry dates back about twenty years, when Mr. Avery began his investigation, which resulted in the process which he covered from 1881 to 1885 by American and foreign patents. The production of the acid on a large scale by fermentation is interesting because it employs micro-organisms to split up the glucose molecule into two molecules of ethylidene lactic acid. The micro-organism that does this work is well known as the bacillus acidi lactici.

The manufacture of lactic acid has three divisions —the preparation of the saccharine solution, the fermentation and the conversion of the fermented liquor into commercial lactic acid. For complete decomposition the saccharine solution should not vary between the limit 1·05 to 1·075 specific gravity. A solution of that density will contain from 7½ to 11 per cent. of saccharine matter. To do its work thoroughly, the lactic bacillus needs to be well nourished by nitrogenous matter. The most convenient form for this nitrogenous material is as it comes from vegetable life—as extracted, for instance, from bran by the action of boiling water and dilute acid. The requisite saccharine solution made up and boiled for at least an hour, to make sure of sterilization, is conveyed into the fermentation tank. There it is rapidly cooled to 55° C. or lower, not going below 45°, and impregnated. Impregnation takes place at a higher temperature than observers have generally stated, a peculiarity perhaps arising from the large scale at which the work is carried on. In continuous manufacture the ferment solutions are impregnated from a preceding ferment liquor, in which a lively fermentation is in progress. For an original impregnation, lactic bacteria must be obtained from an outside source. I prefer to use for that source milk that has been allowed to stand at a temperature of 45° until slightly sour.

The impregnation accomplished in the saccharine solution, the main process in the manufacture of lactic acid is begun. The success or failure in the manufacture depends wholly in the management of the fermentation. For economical production, over 90 per cent. of the glucose must be converted into lactic acid. Any unconverted glucose works a double injury, not only being a loss of material, but also making the resultant lactic acid liable to subsequent decompositions. As the fermentation progresses, the solution must be neutralized with milk of lime, or chalk in suspension. If the fermenting solution is overneutralized, the butyric ferment will at once begin to act, and, once active, is very difficult to control. It is the greatest enemy to the lactic fermentation, destroying the lactic acid that has been made, and devouring new quantities as fast as they can be produced. In twenty-four hours one-third of the lactic acid may be destroyed by the butyric bacillus. Antiferments cannot be used with much safety in lactic fermentation. The lactic bacillus is more susceptible than other ferments, and is killed while others are only stagnated. When the fermentation is ended the liquor must be heated sharply to kill all bacteria and spores and prevent subsequent fermentation.

The fermented liquor, which is now a solution of calcium lactate, with a multitude of dead lactic bacteria floating in it, is filtered and evaporated. If a pure lactic acid is desired, the calcium lactic is allowed to crystallize, and then is purified by repeated crystallization. For a commercial lactic acid, decomposition by sulphuric acid of the dense uncrystallized solution of calcium lactic gives an acid of sufficient purity. The free acid obtained from this decomposition is further concentrated to such strength as the market demands. A 50 per cent. solution is about as concentrated as it is economical to manufacture. This appears on the market as a sirupy liquid, with more or less brown color, and a specific gravity of 1·20 and contains about seven per cent. of lactic anhydride.

Indelible Ink for Paper.—The indelibility of the ink made from the subjoined formula depends on the fact that when potassium bichromate and gelatin come together, particularly in the form of a thin film, in the presence of daylight, the film becomes insoluble in hot or cold water. The formula reads:

Gelatin	2 grammes.
Potassium bichromate	2 "
Nigrosine	10 "
Water	1 fl. oz.

Dissolve the gelatin and nigrosine in most of the water, and the potassium bichromate in the remainder. Mix the two solutions in an amber colored bottle. If it is found that the ink "gums" in the pen, the quantity of gelatin and bichromate may be somewhat reduced. But the ink, when properly made and dry, cannot be entirely removed from paper by hot or cold water, acids or alkalies.—American Druggist.

Spots on Cigars.—The imitation of the spots which are natural to Cuban leaf tobacco seems to be a piece of information very much in demand just at present (probably from the scarcity of the genuine article), and we have answered the query several times within the last few months. For the benefit of new subscribers, however, we will repeat it once more. Proceed as follows: Into an earthen or enameled vessel put 3 parts of sodium carbonate. Pour over it 8 parts of boiling water, let boil until solution takes place and then add 1 part of calcium chloride. Let cool and pour into earthen or stoneware jugs, cork tightly and seal securely to prevent the escape of gases. Keep in a cool place. Either Labarraque's solution or javelle water of commerce answers the purpose admirably.—National Druggist.

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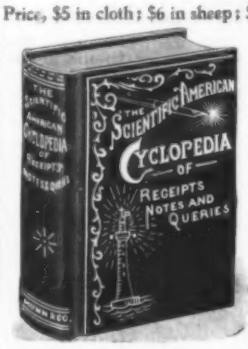

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